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DIRECTOR NOTES

This month the 49th Shock and Vibration Symposium will be held. Those attending the Opening Session will hear about the increased emphasis on large space structures technology. Space missions involving large, flexible structures have been considered for years, but it is the Space Shuttle's capability to handle these structures that has provided the impetus for a major program to move the structural designs from the paper to the hardware stage in a reasonable time frame. The structures to be used may be deployable, built on the earth and unfolded in space, or they may actually be erected while in orbit. In any event, we are faced with significant new challenges in structural dynamics.

Structural analysis techniques will be a major area of emphasis, since full-scale tests of such systems will not be possible on the ground. For the first time a total functioning system will be built in space, while never having been built on earth. Furthermore, a new set of dynamic problems will be faced. The extreme flexibility of the structures means very low natural frequencies and high excursions. Factors related to the operation of structural flexibility and momentum exchange controllers will have to be included in the analysis. It looks like there are some exciting prospects for technological breakthroughs. Both the National Aeronautics and Space Administration and the Department of Defense have programs in this area. We look forward to some very interesting publications as a result of their combined efforts.

H.C.P.

EDITORS RATTLE SPACE

ENCOURAGING INNOVATION

A recent editorial in Physics Today* by J.E. Goldman, Chief Scientist of the Xerox Corporation, stressed the continuing concern of the federal government and business about US innovative capacity. The following quote from Goldman's editorial summarizes the situation as he sees it. "What has often been overlooked in these deliberations (those of the business community and of the Commerce Department) and their stated conclusions is the relationship between academic research and the body of industrial innovative capacity. It is, after all, the industrial environment that is most conducive to promoting a discovery or invention to the status of innovation. If we are to invigorate our national capacity to innovate, we must enhance the coupling of the academic technical culture to the fertile innovative fields of business entrepreneurship."

Admittedly Mr. Goldman's goal is a noble one -- but how can it be achieved and is such a coupling of academia and industry a problem. In my opinion it is. I frequently meet engineers in industry who are struggling with problems that could be solved using available technology, However, much of the research performed in academic institutions is never usefully applied. How can the gap between these two groups be closed; in other words, how can the atmosphere for an effective interchange of ideas be created. On the one hand are the skeptics of industry who don't trust the academic community. On the other hand is the academic group who either are not interested in solving real problems or do not know how to get involved.

Goldman suggests that the formation of small technology-oriented companies would help to close the gap. Small companies take undeveloped ideas from large research firms -- including government, industry, and academically-oriented institutions -- and develop them for commercial use. This is a good but limited approach. In my opinion a more sweeping approach to the problem is needed, for instance, an increase in the number of academic consultants and industry advisors. There is presently a body of professors who consult for industry and thus help to develop products and techniques. And some colleges invite engineers from industry to participate in developing curricula and problems for design classes and in other academic affairs. This interaction should be expanded to its fullest potential.

R.L.E.

*Physics Today, 31 (8), Aug 1978.

GUIDED SOUND TRANSMISSION THROUGH LAYERS

N. Romilly*

***Abstract** - This paper reviews the analysis of sound transmission through single and double panels and thick layers. Mathematical methods are briefly described, as is recent experimental work. Suggestions for future research are presented.*

Although the subject of sound transmission through a layer is of practical importance, consideration until recently was restricted mainly to the simplified model of transmission through an unbounded layer. However, boundaries exist in any practical system, and their effects must often be considered if realistic results are to be obtained. This is true, for example, in the case of acoustic test chambers. On a smaller scale acoustical experiments on sound transmission are conducted in a waveguide.

In recent years the study of sound transmission through a bounded layer -- that is, guided sound transmission -- has received considerable attention, and much progress has been made in theoretical and experimental work. This paper is a brief description of the work and the methods used. Mathematical details are not given. For complete details the reader should consult the references. A summary of mathematical methods has been presented [1]. The methods used include normal mode theory and techniques for inverting infinite matrices.

SINGLE PANELS

For a thin layer a frequently used model for theoretical analysis and experiments is a panel occupying the cross section of a waveguide. The waveguides usually have a circular cross section or parallel plane boundaries. Suitable models for the panel include a stretched ideal membrane or a thin elastic plate; these models represent the two extremes in which either stiffness or tension may be neglected. Even with such simple models, however, the boundaries complicate the analysis.

A formal solution in integral form has been published [2] for the transmission of a plane sound wave through an ideal stretched membrane in a rigid duct of arbitrary cross-sectional shape. An approximate solution was obtained for the case of a circular duct cross section. Frequencies of complete transmission or reflection were predicted. An approximate solution to the same problem was obtained with a variational method [3].

Young [4] extended the work of Ingard [2, 3] and found an approximate solution for a membrane replaced by a thin elastic plate. An approximate solution using normal mode methods has been published for the transmission of a particular sound wave, a (0, 1) mode, through a thin elastic plate occupying the cross section of a rectangular waveguide.

The exact solution, in infinite series form, has been presented for the transmission of any axially symmetric sound wave through an ideal stretched membrane occupying a cross section of a circular waveguide [6]. The circumstances under which the exact solution for an incident plane wave agreed with the approximate theory of Ingard were discussed. It was also pointed out that similar analyses would lead to corresponding exact solutions for a membrane in a parallel-plane waveguide and for a clamped plate occupying a cross section of either waveguide.

The exact solution for guided sound transmission through a panel exhibiting both stiffness and tension has been published [7]. For plane wave transmission the results were qualitatively similar to the case of an unstiffened membrane or that of a plate without tension. However, it was noted that stiffness or tension decreased transmission at low frequencies and increased it at higher frequencies. In experiments, the presence of stiffness or tension could produce marked discrepancies from results predicted by neglecting these effects. The differences would be most marked in the neighborhood of resonance frequencies, because of the shift of the resonance peaks. Certain exact solutions have been amenable to easy computation because they involved the summation of one infinite series that was rapidly conver-

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gent at low frequencies [6, 7].

Sewell [8] used the solution for the clamped circular panel to obtain a transmission factor for a reverberant incident field; i.e., for a field produced by a uniform distribution of sources over a cross section of the waveguide. He observed that the clamped edge condition might not always be appropriate -- that in some instances the edge conditions of simple support might be more appropriate. However, the analysis did not apply directly to simple support edge conditions.

Romilly [9] extended Sewell's analysis and obtained the exact solution for the transmission of any symmetric incident waveguide mode through a simply supported elastic plate. The results were more complicated than those for a clamped panel. The solution involved three infinite series, but they were rapidly convergent and thus suitable for computation. For an incident plane wave the transmission was qualitatively the same as for the clamped edge. Quantitatively, however, the effect of simple support edge conditions was to allow greater transmission at low frequencies, but less transmission at higher frequencies. In experimental work the edge conditions could cause considerable discrepancies from predictions based on clamped edges, particularly close to resonances, because of the shift of the resonance peaks. This is especially true when the resonance peaks are sharp.

Romilly's solution [6] has been applied to the transmission of a pulse through a cavity-backed circular plate in a cylindrical waveguide.

DOUBLE PANELS

Sound transmission through double panels is a problem of theoretical and experimental importance. The unbounded case has been considered [15], but until recently, progress in the theory of bounded double partitions was limited. Application of the procedure for single panels would result in a theoretical model of two panels occupying cross sections of a waveguide. The theoretical treatment of such a model would be considerably more difficult than that for a single panel. Each mode incident on the first panel gives rise to an infinite number of transmitted modes; each of these in turn gives rise to an infinite number of reflected modes at the second panel. Each reflected mode at the second panel gives rise to an infinite number of reflected modes at the first panel, and so on, ad infinitum. The probability of finding an exact solution to such a problem appeared doubtful; however, it has been shown [16] that an exact solution is possible. An exact solution was obtained for the problem of the transmission of a symmetric sound wave through a double partition contained in a parallel-plane waveguide with rigid walls. A membrane model was used for the two leaves of the partition. A similar analysis could be applied to the case of a cylindrical waveguide and should also be applicable when the leaves of the partition are elastic plates. The solution gives the transmitted wave corresponding to any incident mode in terms of six singly infinite series. No special assumptions for the parameters describing the model are necessary, including those for the region of critical frequencies. For the important case of an incident plane wave the form of the transmission coefficient involves four real singly infinite series. The result is complicated, but the four series converge rapidly, so that the solution is suitable for computation. One interesting difference from the case of the single panel is that there are in general no frequencies of complete transmission or reflection of a plane wave for the double partition.

THICK LAYER

The case of transmission through a layer that cannot be treated as a parcel -- i.e., a thick layer -- is described in this section. Even though the thin plate model is satisfactory at low frequencies, it is not necessarily suitable for higher frequencies, and a more exact model might be required. The exact solution for sound transmission through a thick layer of an elastic solid in a waveguide with rigid lubricated walls has been published [11]. Each incident mode excited only the same mode on the other side of the layer; the nature of the transmission depended upon the frequency range.

Other boundary conditions have apparently not been studied. Realistic conditions might be bonding of the layer to the walls of the guide or free edges of the solid. If previously described methods are used, the displacement in the solid might be represented by an infinite series of fundamental solutions of the elastic equations. Because each fundamental solution would satisfy the conditions at the walls of the guide, a transcendental frequency equation [12] would arise. A more fundamental difficulty than the fact that no analytical solution of the frequency equation can be given is that fundamental solutions are not sufficient to satisfy all conditions at the interfaces [13]. Alternative approaches using Fourier series expansions also lead to as yet unresolved difficulties. Progress will require consideration of simpler models for the elastic layer [14].

MATHEMATICAL METHODS

For single panels the problem of sound transmission through layers can be formulated either in integral equation form using Green's functions or in terms of normal mode theory. The integral equation approach is useful for approximate solutions. For the exact solutions mentioned above the normal mode method is used. It is briefly described below. The pressure in the waveguide is governed by the usual scalar wave equation. When waves of a particular frequency are considered, the pressure on each side of the panel can be expanded into a series of waveguide normal modes. These normal modes correspond to specific waves that could propagate along the waveguide at the particular frequency in the absence of the panel. The waveguide contains incident and reflected modes on one side of the panel. The other side is assumed to be either infinite or to be terminated by a perfect absorber. A transmitted wave thus travels in one direction. The driving pressure on the panel is calculated from the pressures in the two parts of the waveguide. The driving pressure provides the forcing term in the equation of motion for the panel. The solution to this equation is the motion of the panel as the sum of a free vibration and a forced vibration. The arbitrary constants in the free vibration can be determined in terms of waveguide mode amplitudes using the edge conditions for the panel. After the following steps are carried out -- substitution of these constants into the expression for panel motion and utilization of the conditions that the velocity at each face of the panel must match the corresponding velocity of the fluid in the guide -- the free motion of the panel is expanded in an infinite series of functions orthogonal over the cross section of the waveguide.

An infinite set of equations is obtained from the orthogonality of the modes. These equations relate the amplitudes of the transmitted waveguide modes to those of the incident modes. Finally, the linearity of the equations is used to consider each incident mode separately, thereby reducing the problem of calculating the transmitted wave to that of inverting an infinite matrix. At this point it is usually necessary to apply approximate methods. However, in the important cases mentioned, examination of the form of the matrix allows the exact inverse of the matrix to be found. In this way the exact solution specifying the transmitted wave for any symmetrical incident wave can be obtained.

The solution is in complex form; in order to separate the real and imaginary parts -- and thus calculate the transmission coefficients -- the specific frequency range being considered must be stated in terms of the cut-off frequencies of the waveguide modes. Although the solutions are complicated functions of frequency involving the sums of one or more infinite series, the infinite series converge rapidly, and numerical results can readily be obtained. Frequencies of complete transmission or reflection of a plane wave can be computed. Physical interpretation of the results is difficult, however, especially at high frequencies, because of the coupling between the modes.

For double panels the situation is more complicated, but the procedures are similar. Three regions of the waveguide must be considered, but, after the pressure in each region has been expanded in a series of waveguide normal modes, the driving pressures on each panel can be calculated. The forcing terms in the equations of motion for the two panels allow the motion of each panel to be expressed as a sum of free and forced motions. Arbitrary constants are determined by using the edge conditions for the panels. Application of continuity of fluid and panel velocity at each panel, together with the orthogonality of the modes, yields systems of infinite equations connecting the waveguide mode amplitudes.

The linearity of the equations is used to consider each incident mode separately. The amplitudes of the modes in the region between the panels are eliminated from the equation. Additional manipulation reduces the problem to one of inverting an infinite matrix. During the reduction process, however, another simpler infinite matrix must be inverted. The final matrix is more complicated than that of the single panel case; in addition, the terms of the matrix contain an infinite series. It is remarkable that examination of the form of the matrix enables the exact inverse to be obtained. The inverse gives the exact solution, specifying the transmitted wave for any symmetrical incident wave. The solution involves a number of infinite series and is in complex form. A specific frequency range is necessary so that real and imaginary parts can be calculated. In the case of an incident plane wave the transmission coefficient is a complicated function of frequency involving four infinite series, but the series converge rapidly so that results can easily be computed.

As mentioned previously for the case of a thick layer, with the exception of the case of lubricated boundaries, the mathematical difficulties involved in obtaining exact solutions have not yet been resolved. Procedures similar to those applied for panels should yield solutions when approximate models are used for the layer.

EXPERIMENTAL WORK

Ingard [2] carried out experiments on the transmission of a plane wave through a membrane in a cylindrical waveguide. The results substantially agreed with calculations in the frequency range below the first anti-resonance. A practical difficulty involved obtaining a uniform tension in the membrane.

Young [4] carried out experiments on the transmission of a plane wave through a plate in a cylindrical waveguide. He examined the cases of clamped, simply supported, and elastically supported edges of the plate. He reported reasonable agreement between measurements and calculation up to the first anti-resonance frequency.

Experiments on transmission of a (0, 1) waveguide mode through thin aluminium plates in a rectangular waveguide dealt with clamped and rubber mounted plates [5]. At a low frequency there was reasonable agreement between experimental results and the approximate theory used for the thi[illegible]

Sewell [8] published results of field me[illegible] on brick walls at the Building Research Establishment, England. Comparison of measurements and theory was difficult because the shape and edge conditions of the walls differed from those used in the calculated results.

Flockton and Chapman [10] have carried out extensive experimental work, of which the results quoted are only a small part. They considered transmission of a pulse through clamped aluminium plates that formed a partition across a cylindrical waveguide. The waveguide had a hard termination at a distance beyond the plate and formed a closed cavity. Their recordings, after Fourier analysis, gave the complex transmission coefficient of the plate. Their experiments were in good agreement with the theory over the ranges considered, but there was a discrepancy in the region of the anti-resonance frequency. Instead of one anti-resonance the results seemed to indicate a pair of anti-resonances. The explanation for this discrepancy is not yet clear. Because good agreement was found elsewhere between theory and experiment, it would seem that the mathematical results must be correct and that the model is somehow defective in the region of anti-resonance. It is known that exact mathematical edge conditions are very difficult to achieve, and the simple thin plate model might not always be applicable.

POSSIBLE RESEARCH DIRECTIONS

The theory for single panels has been verified experimentally at low frequencies for plane wave transmission. Exact solutions have been obtained for the transmission of modes of any order at any frequency. Experimental work on the transmission of higher order modes has not yet been undertaken but would be of interest, as would computation of the transmission of these modes. Not even for the lowest plane wave mode study has transmission at higher frequencies been undertaken. Also of interest would be the extension of the work to other forms of guide and to other types of panel and edge conditions.

For double panels, the exact solution has been found for the membrane model of the panel, but numerical results have not yet been computed. Experimental work on guided transmission through double panels would also be of interest. Extension of the theory to two panels that are elastic plates should be possible. Consideration of various other types of panels, waveguides, and edge conditions would also be of interest, as would a study of higher mode transmission and high frequency transmission. Dissipation has been neglected in the exact solutions but could be included in the theory.

Both theoretical analysis and experimental work on transmission through thick layers are needed. With the exception of the exact solution for the case of rigid, lubricated walls of the waveguide, littel progress has been made in the theory of guided transmission through a thick elastic layer. Fundamental mathematical difficulties remain to be resolved for other conditions at the walls of the guide. Progress should be possible, however, using simpler models for the thick layer.

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LITERATURE REVIEW

survey and analysis of the Shock and Vibration literature

The monthly Literature Review, a subjective critique and summary of the literature, consists of two to four review articles each month, 3,000 to 4,000 words in length. The purpose of this section is to present a "digest" of literature over a period of three years. Planned by the Technical Editor, this section provides the DIGEST reader with up-to-date insights into current technology in more than 150 topic areas. Review articles include technical information from articles, reports, and unpublished proceedings. Each article also contains a minor tutorial of the technical area under discussion, a survey and evaluation of the new literature, and recommendations. Review articles are written by experts in the shock and vibration field.

This issue of the DIGEST contains an article which involves mechanical damping of filled plastics. L.E. Nielsen, a consultant, describes the effects of filler agglomeration on damping and mechanical behavior.

The second article contains the second part of a two part article, Recent Progress in the Dynamic Plastic Behavior of Structures, by Professor Norman Jones of the *Massachusetts Institute of Technology*. The article contains a discussion of a few numerical studies on the dynamic plastic response of structures.

MECHANICAL DAMPING OF FILLED PLASTICS

L.E. Nielsen*

***Abstract** - The effects of filler agglomeration on damping and mechanical behavior are reviewed. It has been found that damping and elastic moduli of filled plastics are very sensitive to the state of agglomeration of filler particles.*

Since 1975 [1] the complex damping behavior of filled plastics has been more adequately explained. It is now recognized that the damping behavior of filled plastics and rubbers is related to the state of agglomeration of the filler particles and to the rigidity of these agglomerates. This review is limited to a discussion of the effects of the state of dispersion and agglomeration of filler particles on the modulus and damping of plastics and rubbers.

DEFINITIONS

In this review complete dispersion means that each filler particle is completely surrounded by plastic or rubber; no true particle-particle contacts exist. An aggregate consists of several particles that are in contact and form a discrete unit. The primary particles are glued together so that the aggregate is rigid, and no relative motion of the basic particles occurs within the aggregate during the application of mechanical forces. An agglomerate is also made up of a number of basic filler particles, but the particles can move, and the agglomerate can break if the mechanical forces are great enough. Thus, particle-particle motion can occur within an agglomerate particle if it is subjected to a mechanical force greater than some critical value required to overcome mechanical friction and particle-particle attraction. Both aggregates and agglomerates can agglomerate; the resulting secondary structures are often called flocs.

Agglomerates form for several reasons. One is poor mixing of plastic and filler; poor mixing occurs because the intensity and time of mixing are not sufficient to properly disperse the filler particles. Second, the plastic and the filler may not "like" each other; that is, the filler particles may be more strongly attracted to each other than they are to the plastic, and as a result, the plastic does not wet individual filler particles. In such cases, it is almost impossible to obtain a good dispersion even if the components are mixed for a long time. Of course, the degree of agglomeration increases with filler concentration because the probability of particle-particle contacts increases. It is the nature of the filler-particle surface and not their bulk properties that are important in agglomeration phenomena.

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Damping is defined in terms of the complex dynamic moduli $M^* = M' + iM''$. M^* refers to the complex modulus, M' is the real part of the elastic modulus, M'' is the imaginary part of the modulus, and $i = \sqrt{-1}$. In this review damping is expressed in terms of M''/M'. Note that M''/M' can be related in a simple manner to such damping terms as logarithmic decrement, specific damping capacity, and sound attenuation [2].

EFFECTS OF FILLER AGGLOMERATION ON MECHANICAL PROPERTIES

Values for the elastic moduli of filled plastics can be predicted much more accurately than can values for damping. As a general rule, however, factors that increase the modulus will decrease damping. In most cases, the elastic modulus M of a filled plastic or rubber can be accurately estimated by the equation

$$\frac{M}{M_1} = \frac{1 + AB\phi_2}{1 - B\psi\phi_2}$$

where

$$B = \frac{M_2/M_1 - 1}{M_2/M_1 + A}$$

$$\psi \doteq 1 + \left(\frac{1 - \phi_m}{\phi_m^2}\right)\phi_2$$

M_1 and M_2 are the elastic modulus (shear or Young's) of the plastic and filler, respectively. The volume fraction of filler is ϕ_2; ϕ_m is the maximum packing fraction of the filler. The factor $\psi\phi_2$ is a reduced concentration. The constant A, which is related to the Einstein coefficient, is determined by particle shape and orientation. Tables of A and ϕ_m have been published [1].

A first approximation of the damping of a filled plastic containing a rigid filler when all the damping comes from the plastic has been published [3].

$$M''/M' \doteq M_1''/M_1' \,(1 - \phi_2)$$

The subscript 1 refers to the plastic phase. Other equations give somewhat different values for damping [4, 5].

Factors important in determining the modulus are the values of A and ϕ_m. Both depend strongly upon the state of agglomeration and upon the strength of the interface between the plastic and the filler particles. For example, for perfectly dispersed spheres, A = 1.5 if there is perfect adhesion; i.e., no motion at the interface. A = 0 *if there is no adhesion; i.e.,* slippage at the interface. For random close packing of spheres, ϕ_m has a value of 0.637.

In the case of rigid aggregates both the plastic trapped inside the aggregate and the plastic in the cusps of the rough surface are shielded from mechanical stresses. The apparent volume of such an aggregate is not the true volume of the particles making up the aggregate; rather, the apparent volume is the filler volume plus the volume of trapped plastic. Thus, for large spherical aggregates, the value of A can approach 4 rather than the 1.5 value for dispersed spheres. For this reason, aggregates are very effective in increasing the modulus. Because the filler aggregates are rigid, the damping source is the plastic subjected to mechanical stressses. Because part of the plastic is shielded, damping with aggregates is less than that of a system containing dispersed spheres [6]. Typical values for aggregates are A = 4 and $\phi_m = 0.637^2$ or 0.406.

Considerable recent research has been done in the field of plastic filled with agglomerated particles [7-10]. As long as the mechanical forces are so small that the agglomerates appear to be rigid, the values for the modulus and the damping are the same as those for aggregates. However, great changes occur when the mechanical stresses become great enough to *either break the agglomerates* or cause particle-particle motion within the agglomerates. There is no theory for evaluating the Einstein coefficient or A in this case, but the value must approach zero. The modulus thus drops drastically when particle-particle motion takes place. In addition, damping greatly increases because a new damping mechanism has developed as a result of particle-particle friction.

Several factors determine the degree of agglomeration, the strength of agglomerates, and the coefficient of friction between particles making up the agglomerates: 1) the size of the primary particles, 2) the nature of the filler surface and surface treatments, 3) the temperature of the system relative to the glass transition temperature or melting point of the plastic matrix, 4) and the elastic modulus of the plastic. The first two factors determine the extent of agglomeration, the strength of the agglomerates, and the friction between particles. The last two factors largely determine the magnitude of the mechanical stresses that the plastic matrix can exert *on the agglomerated particles.*

Changes in temperature cause complex changes in damping and in the elastic moduli of plastics filled with agglomerated particles. These changes are best understood in terms of relative moduli and damping: i.e., the modulus or damping of the filled system divided by the modulus or damping of the unfilled plastic at the same temperature. The relative modulus of a rigid plastic tends to increase with temperature for two reasons: thermal stresses decrease as the glass transition or melting point is approached [11]; less particle-particle motion occurs within agglomerates as the stiffness of the plastic decreases. At a temperature close to the glass transition temperature -- where damping passes through a very large maximum -- the relative modulus passes through a pronounced maximum. The maximum in relative modulus is associated with changes in the agglomerates; they become apparently rigid aggregates because the reduced stresses applied to the agglomerates decrease as the true modulus drops by a factor of roughly a thousand as it passes through the glass transition [10]. In the rubbery state, at temperatures above the glass transition, the relative modulus decreases with increasing temperature, and the relative damping increases. The reason for this behavior is largely due to the mismatch in the coefficients of expansion of the plastic and filler. The mismatch reduces the squeezing forces of the plastic on the agglomerates. These reduced forces either allow plastic-filler slippage at the interface or so decrease the mechanical friction forces that particle-particle motion within the agglomerates can again occur [10].

It is apparent from the above discussion that surface treatments of the filler particles can greatly modify the damping behavior of filled plastics [10, 12].

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RECENT PROGRESS IN THE DYNAMIC PLASTIC BEHAVIOR OF STRUCTURES PART II

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Abstract - This two-part article reviews the literature on the dynamic plastic response of structures published since 1975. The review focuses on the behavior of such simple structural components as beams, plates, and shells subjected to dynamic loads that cause extensive plastic flow of material.

Part I dealt with recent work on the behavior of ideal fiber-reinforced beams, higher modal response of beams, the influence of transverse shear and rotatory inertia, approximate methods of analysis, rapidly heated structures, fluid-structure interaction, and dynamic plastic buckling. Part II contains a discussion of a few numerical studies on the dynamic plastic response of structures and some miscellaneous comments and concluding remarks.

NUMERICAL STUDIES

A number of computer programs are available for studying the dynamic plastic behavior of structures. A brief review of some of the finite-difference and more recent finite-element numerical schemes has been given [1] [1].

The Aeroelastic and Structures Research Laboratory at the Massachusetts Institute of Technology has been developing both finite-difference and finite-element numerical procedures for the dynamic behavior of structural problems. Leech, Witmer, and Morino [72] used the finite-difference computer code PETROS 3 to study the dynamic response of a variable-thickness, double-layer, clamped-ended, elastic-plastic conical shell subjected to a frontal cosine external pressure pulse. This computer program has now been expanded [73, 74] to include features related for the most part to thicker shells, thin non-Kirchhoff soft-bonded shells, and/or honeycomb shells. The capabilities of the PETROS 4 finite-difference computer program have been discussed [74].

Work has continued on a finite-element numerical scheme for the dynamic response of structures [75, 77-79]. Wu [75] demonstrated that his numerical predictions for the deformed profile of a fully-clamped impulsively-loaded rectangular plate agreed well with corresponding experimental results [76]. Wu and Witmer [77] further developed the spatial finite-element and temporal finite-difference scheme in order to study a broader class of structural problems. They obtained somewhat better agreement with experimental results recorded during the dynamic elastic-plastic response of a cylindrical shell panel than had been reported previously for a computer code using a finite-difference procedure.

Numerical predictions for the nonlinear transient responses of geometrically stiffened cylindrical panels and rings compared favorably with corresponding experimental results [78, 79]. A finite-element scheme thus provides efficient and accurate predictions for the transient behavior of structural problems involving large deflections and elastic-plastic material behavior.

The numerical schemes of Wu and Witmer have been used to examine the dynamic response of strain rate-insensitive, elastic, perfectly plastic, fully-clamped beams subjected to impulsive velocity fields distributed with first, second, and third modal forms [15]. The maximum permanent transverse displacements for the three modal forms were similar to the corresponding simple theoretical predictions for a rigid, perfectly plastic beam; the influence of finite transverse displacements was included [14]. A number of assumptions typically made in theoretical studies in this general area have been examined with the computer program [15]. Generally speaking, the in-plane displacements are one order of magnitude smaller than the associated lateral or transverse displacements. The usual procedure for estimating energy ratios [80] was found to be conservative, at least for the problems considered.

The considerable expense usually associated with numerical finite-element studies, especially for dynamic nonlinear problems has led to the develop-

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[1] For references 1-71, see the Sept., 1978, issue of the digest

ment of an alternative numerical scheme, in which a structure is replaced by an "equivalent" system of small rigid bodies connected to springs that are distributed over the contact areas between bodies. This numerical scheme has been used to predict the dynamic elastic-plastic response of a beam [81] and a square plate [82]. However, the influences of finite transverse displacements, or geometric changes, and material strain rate sensitivity [1] are not retained; further work is therefore necessary to demonstrate the accuracy of the method and to appraise the costs associated with more complex problems.

Many other computer programs have been written to examine the dynamic plastic response of either structural components or general structural geometries. A few are mentioned in the following paragraphs.

Some general theoretical principles have been developed and various numerical procedures formulated for predicting the dynamic plastic behavior of structures [50, 83-85]. Visco-plastic and large displacement effects were considered [83]; material elasticity, material work hardening, and geometric changes were retained in the basic equations used in one procedure [84]. Some of the the studies [50, 85] were restricted to infinitesimal displacements; elastic effects were retained in one [50] and the influence of material strain hardening and strain rate effects in another [85]. Beam and frame impact problems were also examined [85].

Erkhov [45] formulated the dynamic infinitesimal response of rigid perfectly plastic structures as a linear programming problem that could be solved using the simplex method. He used his procedure to investigate the dynamic plastic behavior of circular and square simply-supported plates subjected to uniformly distributed pressure pulses with a rectangular pressure-time history.

Ni and Lee [86] used a numerical scheme based on their minimum principle for dynamically loaded elastic-plastic continua with finite-deformations. They were able to predict excellent agreement with numerical and experimental results for cylindrical shell panels [87], with experimental results for rectangular plates [76], and with theoretical predictions for cylindrical shells [88].

Bieniek, Funaro, and Baron [89] sought ways to simplify numerical studies on the dynamic large displacement response of elastic-plastic stiffened shells with arbitrary geometry. Bieniek [90] discussed numerical difficulties associated with investigations into the dynamic buckling behavior of elastic-plastic structures.

One difficulty associated with all theoretical and numerical studies on the dynamic inelastic behavior of structures has been the paucity of information on the constitutive equations for materials, especially in the dynamic regime. The influence of material elasticity, material strain hardening, and strain rate sensitivity have been briefly discussed [1]. The multi-dimensional constitutive equations are invariably constructed according to the properties observed during uniaxial tests [1, 62, 66, 80]. Moreover, the form of the multi-dimensional constitutive equations for elastic-plastic materials is not yet clear, even for static problems [91]. This shortcoming is compounded for dynamic problems because little experimental information exists for strain rate history effects or combined loadings [92].

Bodner and Partom [93-95] have developed a constitutive equation that is not based on the usual concept of a yield surface. Rather, the incremental constitutive equations are functions of state variables and the current geometry; both can account for all history and memory effects. Bodner and Partom used the concepts of dislocation dynamics to provide a physical basis for their constitutive equations. They claim these equations are ideal for numerical schemes because no special conditions are required to distinguish loading and unloading paths. Recently, Sperling and Partom [96] developed a numerical finite-difference procedure based on the Bodner-Partom constitutive equations. They examined the dynamic elastic-visco-plastic large deflection behavior of a beam.

COMMENTS

The previous sections of this review have surveyed insofar as possible the literature published during the last three years. The active area of numerical methods, for instance, would require an entire article. Many theoretical studies and practical dynamic problems involve material inelasticity. This section contains a sampling of the many current activities on the dynamic plastic response of structures and is not intended to be comprehensive.

Experimental Studies

Forrestal and Wesenberg [97, 98] performed dynamic experimental tests on simply supported beams made from either aluminum 6061 T6 or mild steel. The beams were subjected to a short duration magnetic pressure pulse with a half-sine wave shape; the experimental arrangement was similar to that used previously for rings [99]. Simple approximate elastic-perfectly plastic and elastic-visco-plastic theoretical procedures were developed to predict peak transverse displacements [97, 98]. The results were in excellent agreement with corresponding experimental values.

Experimental studies on the dynamic plastic behavior of other beams have been reported [13, 96, 100]. Bodner and Symonds [40] conducted an experimental investigation on simple plane metal frames loaded dynamically. Experiments on the dynamic plastic behavior of fully-clamped circular plates have been reported [38, 41]. The dynamic plastic response of a freely suspended cylindrical shell has been examined [38]. An experimental investigation into the dynamic plastic bukcling of circular rings has been reported in reference [64] in which the literature on the experimental work involving dynamic plastic buckling of rings and cylindrical shells was also reviewed.

An experimental investigation into the structural characteristics of high explosive containment in cylindrical vessels has been conducted [101, 102]. Simple rigid-plastic theoretical procedures were also developed that provided reasonable estimates for the permanent radial deformations of the walls of cylindrical vessels, either with or without end caps [101, 102].

Theoretical and Numerical Studies

Many theoretical and numerical studies have already been mentioned in this review. A few additional articles are now briefly described.

Krajcinovic [103] derived a theoretical rigid perfectly plastic solution for the dynamic infinitesimal displacement response of a simply-supported beam subjected to a uniformly-distributed dynamic load with an arbitrary pressure-time history. Youngdahl [104] examined the dynamic plastic behavior of a rigid perfectly plastic hexagonal frame subjected to an internal pressure pulse with an arbitrary shape. The influence of finite displacements, or geometric changes, was retained in the governing equations.

The behavior of a multilayered spherical vessel subjected to a spherically symmetric intermittent internal pressure pulse has been examined [105]. The vessel consisted of N concentric unsupported spherical shells made from an elastic-linear work hardening material; the shells were separated by evacuated gaps. The pressure pulse caused the inner layer to move outward and strike the second layer. The two layers moved outward together until wave interactions caused them to separate. The second layer then struck the third layer, and the process was repeated.

Lepik and Mroz [106] used a mode approximation procedure to obtain the optimal design of rigid-plastic structures subjected to dynamic loads. They sought the design that gave the minimum permanent displacements of a structure with a given constant volume of material. The case of a stepwise constant thickness beam subjected to a uniformly distributed pressure-pulse with a rectangular pressure-time history was examined in some detail. The maximum permanent deflection of an optimal two-step (per half span) beam was found to be one-half the corresponding permanent deflection of a uniform beam having the same volume. The impulsive loading of beams and circular plates was also examined [106].

Menkes and Opat have continued their work on the dynamic fracture of structures subjected to very high pressures for very short times. They presented the theoretical foundations for a finite-element numerical procedure for simple structures that undergo large deformations and localized ruptures [107].

Collision Protection of Vehicles

Many articles have been written on the collision protection of various air, land, and water vehicles; some of this literature has been reviewed [4, 63, 80, 108, 109]. A few recent theoretical and experimental studies on the dynamic inelastic response of various components of interest in vehicle crashworthiness are briefly discussed in this section.

The dynamic axial collapse behavior of thin-walled steel box sections has been examined [110, 111]. The response of circular tubes [112], corrguated tubular sections [113], and beam-columns subjected to dynamic axial loads [114] has also been investigated. The review by Thornton and Dharan [115] contains comments on the dynamic axial buckling of structures.

Shieh [116] developed a general purpose computer program for the large displacement dynamic response of elastic-viscoplastic plane frames. The numerical predictions of the program agreed reasonably well with the experimental behavior of a steel plane frame dropped onto a narrow, rigid pole. McIvor and Anderson [117] also reported a numerical and experimental investigation into the inelastic response of a frame striking a pole. The large deformations of frames loaded statically have been studied for insight into the behavior of structural members in vehicles [118, 119].

Garnet and Armen [120] used a finite-element procedure to examine the mechanics of impact and rebound of an elastic-linear work-hardening rod subjected to axial forces; the forces were applied and removed periodically, and the rod hit a rigid wall at right angles. Lush and Witmer [121] conducted some experimental tests to study the impact characteristics of rodlike missiles striking either a flat rigid barrier or the midspan of a fully-clamped beam. The missiles had a crushable forebody made from a semirigid polyurethane foam and a comparatively rigid aluminum afterbody.

The theoretical and experimental behavior of inversion tubes and rolling torus load limiters under static and dynamic axial loads has been examined [122-124]. Tong and Rossettos [125] used a modular concept to develop a numerical procedure for estimating the structural deformations sustained by vehicles during collisions.

CONCLUDING REMARKS

Material inelasticity plays an important role in many dynamic structural problems. Some studies [104, 126] have been motivated by the nuclear engineering industry; others [61-63, 109, 127] are related to ship and marine vehicle design. Still others have been concerned with the collision protection of automobiles. Energy-absorbing systems [7, 13, 15, 122-124], defense [20, 53, 60, 107, 128], and the earthquake resistance of buildings [129] have also been studied. Simple rigid-plastic analyses could be used for some of the design problems for buildings subjected to severe dynamic loads [130].

It is hoped that this survey article, together with the earlier one [1], will allow a reader to obtain the information sought and provide some insight into the advantages and disadvantages of various experimental, numerical, and theoretical approaches to the solution of dynamic structural problems.

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BOOK REVIEWS

FLOW-INDUCED STRUCTURAL VIBRATION

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Springer-Verlag, Berlin, Heidelberg, New York

Flow-induced structural vibration is important in many areas, including fluid mechanics, hydraulics, and acoustics. This compilation of material presented at the Flow-Induced Structural Vibration Symposium held at the University of Karlsruhe, Germany on August 14-16, 1972 is concerned mostly with fluid mechanics. The symposium consisted of 49 papers, five general lectures, and a panel workshop. The papers were assigned to eight sessions, labeled A-H.

The chapter dealing with Session A has to do with the flow of fluid in the air chamber, neppe oscillations, flapping jets, oscillation of a jet in a rotating fluid, and hydraulic instability in a pressurized water reactor.

The informative chapter on Session B stresses mathematical models of flow-induced vibrations. Pertinent topics include wake and vortex shedding past a single cylinder, prediction of flutter forces, low frequency components of separated flows, and fluctuating pressures on bluff bodies. This chapter contains a tremendous amount of information. The subjects have generated many papers in technical journals during the past few years.

Session C had to do with the role of hydraulic systems in initiating flow-induced vibration. At one time little thought was given to the dynamics of hydraulic systems except for instability. This chapter contains information on the vibration of vertical left gates, dam and gate vibrations, and vibrations of swing check valves and gate valves. A paper on flow-induced structural oscillations compares analyses with hydronamic measurements on structures.

Flow-induced vibrations of beams and bridge docks, the topic of Session D, have been studied since the Tacoma Narrow Bridge disaster, Flutter -- the cause of the bridge failure -- as well as vibration and aerodynamic theory have played important roles in the design of bridges and the wings, tail surfaces, and turbine blades of airplanes. The various papers discuss flutter, aerodynamic response to turbulent wind, torsional oscillations of H sections in random gusts, and torsional oscillations. Buildings oscillate during random gusts and winds. A paper on wind tunnel tests shows its application to design.

Session E considered flow-induced vibrations of bluff bodies. They include unsteady aerodynamics of wings and blades, unsteady pressure oscillations on circular cylinders, flow-induced oscillations of cantilevered cylinders in water, and vortex-induced vibrations of triangular cylinders. One paper covered the correlation between forces and flow-field features for bluff cylinders. The reviewer considers this session a most informative one.

Session F had to do with flow-induced vibrations of marine structures; such vibrations have become prominent in the past few years. An excellent paper on ocean wave spectra and eddies is recommended for readers interested in ship design. Other papers consider oscillations of full-scale piles, vibrations of mooring lines, hydrofoil flutter, hydroelastic motion of two cylinders on cylindrical supports, and flow-induced vibrations of two cylinders in tandem.

Flow-induced vibrations of shells and pipes are important in power plant and reactor design. The papers of Session G consider various problems in such design, as well as in smoke stacks.

Session H, flow-induced vibrations relating to buildings, was also discussed in Session D. The response of buildings to flow-induced stimuli has become a topic of importance due to recent wind damage of large buildings. This session also considered turbulence-induced vibration and vortex generation in a wind tunnel on bluff buildings -- a modern design approach. Other papers discuss wake galloping, which is an oscillation instability, and plus galloping oscillations of prisms in smooth and turbulent flow.

In summary, this is an excellent book, and the editor is to be congratulated. The reviewer would have liked to have seen papers on aircraft noise and acoustic failures due to sonic fatigue in both aircraft and reactors. Many of the papers from this symposium are of interest to the engineer and scientist engaged in flow-induced vibrations. The symposium served as an introduction to the world of dynamic fluid mechanics, and the book is a must for workers in this field.

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CLASSICAL AND MODERN MECHANICS

J.H. Bartlett
The University of Alabama Press, University, AL
1975

This book is a no-nonsense collection of a number of the paths that have led to modern mechanics. The complexity of the material increases from chapter to chapter; however, Bartlett effectively maintains a style of simplicity and readability. Excess mathematical complexity has been eliminated, and a minimum number of variables (often just one) have been used to explain and illustrate the concepts. This book is written for the engineer and scientist with a good grasp of elementary physics.

The text is not polished but is rather a collection of type-written sheets and diagrams. The table of contents is adequate; appendices, references, and an author's index are included, but there is no subject index.

Much of the motivation for this book derives from the author's experience as teacher and investigator in the field of high-energy accelerators, the restricted three-body problem, and stability problems for systems having periodic characteristics.

The first two chapters, "Simple Motion" and "General Equations of Motion," contain the elementary theory, which is applied and expanded in succeeding chapters.

The directness and simplicity of Bartlett's style of presentation is illustrated by his definition of potential energy. His simple, rather nonmathematical, explanation is more satisfying than the normal three-dimensional vector presentation involving the introduction of exact scalar differentials, the potential energy function, and potential energy.

Succeeding chapters examine the elliptic functions associated with the pendulum and top; the two-body problem, magnetic dipoles, Faraday's law, and Maxwell's equation.

The advanced nature of the book becomes evident in chapters covering the betatron, linear accelerator, the dynamics of special and general relativity, and contact transformations for the analysis of beams or particles. Other sections deal with general autonomous systems, the stability of periodic nonautonomous systems, motion in the field of a magnetic dipole, and the restricted three-body problem.

This book should be of interest to advanced graduate students and researchers working in the general areas described above.

M. Taylor
Applied Mechanics Division
University of Virginia
Charlottesville, VA 22901

VIBRATION: BEAMS, PLATES AND SHELLS

A. Kalnins and C.L. Dym, Editors
Halsted Press, 1976

This book is one of a series of **Benchmark Papers in Acoustics**. Each of the other volumes deals with a particular subject in acoustics. Titles and editors of the other eight volumes are: Underwater Sound, V.M. Albers; Acoustics, Historical and Philosophical Development, R.B. Lindsay; Speech Synthesis, J.L. Flanagan and L.R. Rabiner; Physical Acoustics, R.B. Lindsay; Musical Acoustics Part I, Violin Family Components, C.M. Hutchins; Musical Acoustics Part II, Violin Family Functions, C.M. Hutchins; Ultrasonic Biophysics, F. Dunn and W.D. O'Brien; Musical Acoustics, Piano and Wind Instruments, E.L. Kent. The series editor is R.B. Lindsay.

This most recent volume contains 41 papers under the following headings:

- Vibration and Waves in Beams, five papers
- Vibration and Waves in Plates, ten papers
- Free Vibration of Shells, ten papers
- Dynamic Response of Shells, six papers
- Nonlinear Vibration, six papers
- Damping, four papers.

Each section contains a brief, clear, and well written summary of the highlights of each paper and, in some instances, a perspective vis-a-vis other papers on the same topic.

The papers range from early contributions of basic technical importance but mostly of historical interest to papers of considerable analytical and practical importance that were published during the past 25 or 30 years and are still useful to papers that seem mostly of academic interest and thus have limited significance.

Among the papers of historical interest is a three-page excerpt from Theory of Sound, in which Lord Rayleigh rationalizes his separation of shell vibrations into extensional and inextensional cases. Also included is Love's paper on thin shells containing a critique of Rayleigh's point of view. Other historical papers include that of Timoshenko on the correction for shear in beams and that of Reissner on his shallow shell theory. Papers on waves are by Lamb, Miklowitz, Mindlin and his colleagues, Gazis, and others. Several papers on nonlinear vibrations are also included.

Papers of considerable importance published in the past 30 years include Young's paper on vibration of rectangular plates containing tables of mode shapes and frequencies under various boundary conditions. Also in this category is the expository paper by Crandall on the role of damping in vibration theory.

A number of excellent scholarly papers deal in many instances with narrowly defined academic or esoteric problems. Nevertheless, these papers are excellent examples of careful research and, in some cases, elegant analysis.

The editors indicate in the Preface that they have chosen papers not necessarily for their originality but for their clarity. Clarity, however, is a subjective measure and cannot substitute for what should have been an objective selection of benchmark papers. Fortunately, most of the papers are significant ones, but the substitution of originality by the subjective measure of clarity opens the door to the possibility of parochialism in the selection process. Other editors undoubtedly would have faced the same problems in making selections and perhaps would have fallen into the same trap.

John E. Goldberg
Guest Professor
Ruhr-Universität Bochum
Institut f. Konstruktiven Ingenieurbau
463 Bochum-Querenburg, Postfach 2148

SHORT COURSES

OCTOBER

VIBRATION DAMPING

Dates: October 23-26, 1978

Place: University of Dayton Research Institute

Objective: To cover the science and art of utilizing vibration damping materials to reduce the undesirable effects of noise and vibration on structures and equipment. The course is designed to teach the background, basic analytical methods and experimental techniques needed for design and application of damping treatments in aircraft and spacecraft structures, engines and equipment. Step by step procedures will be discussed, along with case histories. The fee for early registration is $410 (before October 2, 1978) and $425 thereafter.

Contact: Vibration Damping Short Course, Research Institute - KL 501, University of Dayton, Dayton, OH 45469, Attn: Dale H. Whitford, (513) 229-4235.

MACHINERY VIBRATION SEMINAR

Dates: October 24-26, 1978

Place: MTI, Latham, New York

Objective: To cover the basic aspects of rotor-bearing system dynamics. The course will provide a fundamental understanding of rotating machinery vibrations; an awareness of available tools and techniques for the analysis and diagnosis of rotor vibration problems; and an appreciation of how these techniques are applied to correct vibration problems. Technical personnel who will benefit most from this course are those concerned with the rotor dynamics evaluation of motors, pumps, turbines, compressors, gearing, shafting, couplings, and similar mechanical equipment. The attendee should possess an engineering degree with some understanding of mechanics of materials and vibration theory. Appropriate job functions include machinery designers; and plant, manufacturing, or service engineers.

Contact: Mr. Frank Ralbovsky, MTI, 968 Albany-Shaker Rd., Latham, NY 12110 - (518) 785-2349.

STRUCTURAL ANALYSIS SHORT COURSE

The following short course in structural analysis is being offered by Schaeffer Analysis in October of 1978 in Boston, Massachusetts.

Composite Materials

- Structural Applications of Composite Materials
  October 23-26, 1978

Contact: Schaeffer Analysis, Kendall Hill Road, Mont Vernon, New Hampshire 03057 - (603) 673-3070.

MECHANICAL RELIABILITY AND PROBABILISTIC DESIGN FOR RELIABILITY

Dates: October 30-November 3, 1978

Place: The George Washington University

Objective: Topics to be discussed include the probabilistic-design-for-reliability or the stress-strength-distribution-interference approach to design; the comparison of the conventional design to the probabilistic-design-for-reliability methodology; the determination of the failure-governing stress and strength distributions; the computation of the associated reliability with a desired confidence, and the prediction of the reliability of components and structural members subjected to static or to fatigue loads.

Contact: Continuing Engineering Education Program, George Washington University, Washington, D.C. 20052 - (202) 676-6106 or toll free (800) 424-9773.

NOVEMBER

DIGITAL SIGNAL PROCESSING

Dates: November 6-10, 1978

Place: The George Washington University
Washington, D.C.

Objective: *The course is designed for engineers, scientists, technical managers, and others who desire a better understanding of the theory and applications of digital signal processing. The objective of this course is to provide the participants with the essentials of the design of IIR and FIR digital filters, signal detection and estimation techniques, and the development of Fast Fourier Transform Algorithms. The applications of digital signal processing to speech processing will also be discussed. The mathematical concepts needed for understanding this course will be developed during the presentation.*

Contact: Continuing Engineering Education Program, George Washington University, Washington, D.C. 20052 - (202) 676-6106 or toll free (800) 424-9773.

VIBRATION AND SHOCK TESTING

Dates: November 6-10, 1978
Place: Washington, D.C.

Objective: Lectures are combined with physical demonstrations: how structures behave when mechanically excited, how input and response forces and motions are sensed by pickups, how these electrical signals are read out and evaluated, also how measurement systems are calibrated. The relative merits of various types of shakers and shock machines are considered. Controls for sinusoidal and random vibration tests are discussed.

Contact: Wayne Tustin, Tustin Institute of Tech., Inc., 22 East Los Olivos St., Santa Barbara, CA 93105 - (805) 963-1124.

VIBRATION AND SHOCK SURVIVABILITY

Dates: November 6-10, 1978
Place: Ling Electronics, Anaheim, California

Objective: Topics to be covered are resonance and fragility phenomena, and environmental vibration and shock measurement and analysis, also vibration and shock environmental testing to prove survivability. This course will concentrate upon equipments and technqiues, rather than upon mathematics and theory.

Contact: Wayne Tustin, 22 E. Los Olivos St., Santa Barbara, CA 93105 - (805) 963-1124.

16TH ANNUAL RELIABILITY ENGINEERING AND MANAGEMENT INSITUTUTE

Dates: November 6-10, 1978
Place: Tuscon, Arizona

Objective: The course will cover the following topics: Reliability engineering theory and practice; Mechanical reliability prediction; Reliability testing and demonstration; Maintainability engineering, Product liability; and Reliability and Maintainability Management.

Contact: Dr. Dimitri Kececioglu, Aerospace and Mechanical Engineering Dept., University of Arizona, Bldg. 16, Tucson, AZ 85721 - (602) 626-2495/626/3901/626-3054.

MACHINERY VIBRATIONS COURSE

Dates: November 13-16, 1978
Place: Oak Brook, Illinois

Objective: This course on machinery vibrations will cover physical/mathematical descriptions, calculations, modeling, measuring, and analysis. Machinery vibrations control techniques, balancing, isolation, and damping, will be discussed. Techniques for machine fault diagnosis and correction will be reviewed along with examples and case histories. Torsional vibration measurement and calculation will be covered.

Contact: Dr. Ronald L. Eshleman, Vibration Institute, Suite 206, 101 West 55th St., Clarendon Hills, IL 60514 - (312) 654-2254.

JANUARY

STRUCTURED PROGRAMMING AND SOFTWARE ENGINEERING

Dates: January 8-12, 1979
Place: The George Washington University

Objective: This course provides up-to-date technical knowledge of logical expression, analysis, and invention for performing and managing software architecture, design, and production. Presentations will cover principles and applications in structures programming and software engineering, including stepwise refinement, program correctness, and topdown system development.

Contact: Continuing Engineering Education Program, George Washington University, Washington, D.C. 20052 - (202) 676-6106 or toll free (800) 424-9773.

FEBRUARY

VIBRATION AND LOOSE PARTS MONITORING SYSTEMS AND TECHNOLOGY

Dates: February 5-8, 1979

Place: Los Angeles, California

Objective: A course designed for users, utility designers specifying systems, installers, operators, and analysts of Vibration and Loose Parts Monitoring Systems. Classroom instruction in theory, installation, calibration, alarms and location, signature analysis, noise analysis, and troubleshooting and servicing. Practical demonstration includes student "hands-on" operation of equipment.

Contact: C.A. Parker, Nuclear Training Center, Atomics International, P.O. Box 309, Canoga Park, CA 91304 - (213) 341-1000, Ext. 2811.

FLOW-INDUCED VIBRATION PROBLEMS AND THEIR SOLUTIONS IN PRACTICAL APPLICATIONS: TURBOMACHINERY, HEAT EXCHANGERS AND NUCLEAR REACTORS

Dates: February 12-16, 1979

Place: The University of Tennessee Space Inst.

Objective: The aim of the course is to provide practicing engineers engaged in design, research and service, an in-depth background and exposure to various problems and solution techniques developed in recent years. Topics to be covered will be the fundamental principles of unsteady fluid flow, structural vibration and their interplay; review of the morphology of flow-induced vibration; state-of-the-art discussion upon theory, experimental techniques and their interaction; methodology of alleviation.

Contact: Jules Bernard, The University of Tennessee Space Institute, Tullahoma, TN 37388 - (615) 455-0631 - Ext. 276 or 277.

MARCH

MEASUREMENT SYSTEMS ENGINEERING

Dates: March 12-16, 1979

Place: Phoenix, Arizona

MEASUREMENT SYSTEMS DYNAMICS

Dates: March 19-23, 1979

Place: Phoenix, Arizona

Objective: Program emphasis is on how to increase productivity, cost-effectiveness and data-validity of data acquisition groups in the field and in the laboratory. The program is intended for engineers, scientists, and managers in industrial, governmental, and educational organizations, Electrical measurements of mechanical and thermal quantities are the major topics.

Contact: Peter K. Stein, 5602 E. Monte Rosa, Phoenix, AZ 85018 - (602) 945-4603/946-7333.

APPLICATIONS OF THE FINITE ELEMENT METHOD TO PROBLEMS IN ENGINEERING

Dates: March 12-16, 1979

Place: The University of Tennessee Space Inst.

Objective: This course will concentrate on material developed recently and provide a solid foundation for those relatively new to the field. Topics to be covered are the treatment of mixed type equations which occur in transonic flow and wave motion in nonlinear solids, mixed type elements which are of importance in systems such as the Navier-Stokes equations, the interrelationship between the equation formation and the iterative scheme needed to solve any of the nonlinear equations the advantages of hybrid elements, and the use of interactive graphics as an aid to problem solution.

Contact: Jules Bernard, The University of Tennessee Space Institute, Tullahoma, TN 37388 - (615) 455-0631. Ext. 276 or 277.

NEWS BRIEFS

news on current and Future Shock and Vibration activities and events

CALL FOR PAPERS
Design and Applications: Advanced Composite Materials

The Mechanical Failure Prevention Group (MFPG) sponsored by the National Bureau of Standards; Office of Naval Research, Department of the Navy; Department of Energy; and NASA Goddard Space Flight Center will hold its 29th Symposium at the National Bureau of Standards, Gaithersburg, Maryland on May 22-24, 1979. Papers are desired in the following areas: Applications in land, marine, and aerospace systems; Analytical techniques, Fabrication techniques; Non-destructive testing; Failure modes; Environmental effects; and Materials. Proceedings in the form of extended abstracts, 2-4 typewritten pages, will be published by the National Bureau of Standards. Closing date for initial abstracts is January 1, 1979 and for extended abstracts, April 30, 1979. Abstracts should be sent to Jesse E. Stern, Code 721, Goddard Space Flight Center, Greenbelt, Maryland 20771 - (301) 982-2657.

ASA ANNOUNCES THE AVAILABILITY OF TWO NEW NOISE STANDARDS

New standards on noise rating with respect to speech intelligibility and criteria for permissible ambient noise during audiometric testing have been published by the Acoustical Society of America. Both documents are American National Standards, having been prepared by Standards Committee S3 of the American National Standards Institute (ANSI). The Acoustical Society holds the Secretariat of the ANSI S1, S2 and S3 committees on Physical Acoustics, Shock and Vibration and Bioacoustics respectively.

The new standards are designated ANS S3.1-1977 (ASA Catalog No. 9-1977), Criteria for Permissible Ambient Noise During Audiometric Testing, and ANS S3.14-1977 (ASA Catalog No. 21-1977), Standard for Rating Noise with respect to Speech Intelligibility. Both documents are avialable for $7.00 each from Dept. STD, AIP Back Numbers Department, 335 E. 45th St., New York, NY 10017. Orders not accompanied by payment will be subject to a $2.00 handling charge.

In addition to these documents, the Acoustical Society has available an index of Noise Standards covering standards published in the United States, International Standards and standards published in other countries. Also available is a noise standards package which includes key American National Standards concerned with noise.

The Society also has available 38 standards on noise, physical acoustics, bioacoustics and shock and vibration which are published by the American National Standards Institute.

Further information on all of the above documents may be obtained from the Standards Manager, Acoustical Society of America, 335 E. 45th Street, New York, NY 10017.

ABSTRACTS FROM THE CURRENT LITERATURE

Copies of articles abstracted in the DIGEST are not available from the SVIC or the Vibration Institute (except those generated by either organization). Inquiries should be directed to library resources. Government reports can be obtained from the National Technical Information Service, Springfield, VA 22151, by citing the AD-, PB-, or N- number. Doctoral dissertations are available from University Microfilms (UM), 313 N. Fir St., Ann Arbor, MI; U.S. Patents from the Commissioner of Patents, Washington, D.C. 20231. Addresses following the authors' names in the citation refer only to the first author. The list of periodicals scanned by this journal is printed in issues 1, 6, and 12.

ABSTRACT CONTENTS

ANALYSIS AND DESIGN

ANALYTICAL METHODS

78-1364

On a Generalization of the Lewis Invariant for the Time-Dependent Harmonic Oscillator

P.G.L. Leach

Dept. of Mathematics, LaTrobe Univ., Bundoora, Victoria 3083, Australia, SIAM J. Appl. Math., 34 (3), pp 496-503 (May 1978) 21 refs

Key Words: Oscillators, Damping

An exact invariant is found for the one dimensional oscillator with equation of motion $\ddot{q} + f(t)\dot{q} + w^2(t)q = 0$. The method used in that of linear canonical transformations with time-dependent coefficients. The significance of extension to higher dimensions of these results is indicated, in particular for the existence of noninvariance dynamical symmetry groups.

78-1365

On the Non-Uniform Convergence of Galerkin's Method

H.H.E. Leipholz and R. Mandadi

Dept. of Civil Engrg., Univ. of Waterloo, Waterloo, Ontario, Canada, J. Sound Vib., 57 (4), pp 483-498 (Apr 22, 1978) 4 figs, 13 refs

Key Words: Galerkin method, Eigenvalue problems

It is generally accepted that the application of Galerkin's method to non-self-adjoint problems of the theory of elastic stability yields reliable results provided that the coefficient determinant of the associated algebraic equation converges. Although this is true in the majority of practical cases, it is shown here that there are exceptions to this rule. An explanation for the occurrence of these exceptions seems to be contained in the statement that the convergence of the coefficient determinant is not always a uniform one. This paper is devoted to a careful study of this aspect.

78-1366

Damped Vibration Eigenvalues in the Case Where a Convergence Hypothesis is Valid (Eigenwerte gedämpfter Schwingungen bei Gültigkeit der Bequemlichkeitshypothese)

S. Falk

Lehrstuhl f. Mech. u. Festigkeitslehre, T.U. Braunschweig, Postfach 3329, D-3300 Braunschweig, West Germany, Ing. Arch., 47 (2), pp 57-66 (1978) 4 figs, 7 refs

(In German)

Key Words: Eigenvalue problems, Vibration damping

The matrix differential equation $M\ddot{u} + D\dot{u} + Cu = o$ of an N-degree-of-freedom linear dynamic system with viscous damping may have the special property $D = \alpha M + \epsilon C$. For this case it is shown that the complex eigenvalues are situated on a circle in the complex λ-plane, determined by the parameters α and ϵ. For the real roots a simple presentation in the λ-plane is given. An extension to continuous systems is possible.

NUMERICAL ANALYSIS

78-1367

The Pulse Response of Nonlinear Third Order Systems

S.G. Joshi and P. Srinivasan

Dept. of Mech. Engrg., Indian Inst. of Science, Bangalore 560012, India, J. Sound Vib., 58 (1), pp 109-115 (May 8, 1978) 2 figs, 8 refs

Key Words: Pulse excitation, Approximation methods, Numerical analysis

The response of a third order non-linear system subjected to a pulse excitation is analyzed. A transformation of the displacement variable is effected. The transformation function chosen is the solution of the linear problem subjected to the same pulse. With this transformation the equation of motion is brought into a form in which the method of variation of parameters is applicable for the solution of the problem. The method is applied to a single axis gyrostabilized platform subjected to an exponentially decaying pulse. The analytical results are compared with digital and analog computer solutions.

STATISTICAL METHODS

78-1368

Statistical Parameters of Estimators in Cross-Spectral Analysis

R.H. Burros
The Port Authority of New York and New Jersey, One Path Plaza, Jersey City, NJ 07306, J. Sound Vib., 58 (1), pp 39-50 (May 8, 1978) 6 refs

Key Words: Statistical analysis, Spectrum analysis

In this paper derivations are presented for exact asymptotic formulas for the means, variances, and covariances of four averaged estimators of physical parameters: two power spectra, the cospectrum and the quadspectrum, at any available discrete positive frequency. The raw estimators are averaged across q statistically independent replications of the experiment, not across nearby discrete frequencies.

78-1369

Some Simple Models Describing the Transition from Weak to Strong Coupling in Statistical Energy Analysis

K.L. Chandiramani
Bolt Beranek and Newman, Inc., Cambridge, MA 02138, J. Acoust. Soc. Amer., 63 (4), pp 1081-1083 (Apr 1978)

Key Words: Statistical energy methods, Coupled response, Forced excitation

Two simple situations are considered of N mutually coupled oscillators excited at resonance by external random sources. Formulas are derived for oscillator energies that display explicitly the transition from weak to strong coupling between the oscillators.

FINITE ELEMENT MODELING

78-1370

An Energy Theory for the Nonlinear Finite Element Methods of Structural Dynamics

S.M. Hamdan
Ph.D. Thesis, Univ. of Southern California (1978) Avail: Micrographics Dept., Doheny Library, USC, Los Angeles, CA 90007

Key Words: Finite element technique, Nonlinear theories, Mathematical models

The purpose of this research is to construct and investigate new algorithms for nonlinear finite element structural analysis problems. The stability criteria of the proposed algorithms are assessed by developing discrete energy conservation laws for conservative systems and by constructing systematic procedures for studying the behavior of the linear energy for nonconservative systems. The class of problems considered is the geometrically nonlinear but materially linear. However, the developed techniques can also be applied to the analysis of problems with different types of nonlinearities.

MODELING

(See No. 1388)

DIGITAL SIMULATION

(See No. 1419)

PARAMETER IDENTIFICATION

78-1371

Parameter Estimations Under Special Consideration of Continuous System Parameters (Parameterschätzungen unter besonderer Berücksichtigung von kontinuierlichen Systemparametern)

H. Wierum
Forschrift-Berichte der *VDI-Zeitschriften*, Series 8, No. 28, 136 pp (1978) 10 figs, Avail: VDI-Verlag G.m.b.H., Postfach 1139, 4000 Düsseldorf, Germany, Taken from VDI-Z., 120 (7), p 282 (1978)
(In German)

Key Words: Parameter identification technique, System identification technique

System and process identification are investigated. Process identification is an experimental analysis of a process for the determination of linear transfer functions.

78-1372

Walsh Series Approach to Lumped and Distributed System Identification

S.G. Tzafestas
Control Systems Lab., Univ. of Patras, Patras, Greece, J. Franklin Inst., 305 (4), pp 199-220 (Apr 1978) 19 refs

Key Words: Parameter identification technique, Lumped parameter method, Continuous parameter method

The problem of identifying the parameters of dynamic systems from input-output records is considered. Both lumped-parameter and distributed-parameter systems, deterministic and stochastic, are studied. The approach adopted is that of expanding the system variables in Walsh series. The key point is an operational matrix P which relates the coefficient matrix Γ of the Walsh series of a given function with the coefficient matrix of its first derivative. Using this operational matrix P the necessity to use differentiated data is overcome, a fact that usually is avoided either by integration of the data or by using discrete-time models.

DESIGN TECHNIQUES

(See Nos. 1399, 1405, 1408, 1501)

CRITERIA, STANDARDS, AND SPECIFICATIONS

78-1373

Consultative Document Issued on ILO Measures to Control Workplace Hazards of Air Pollution, Noise and Vibration

Noise Control Vib. Isolation, 9 (4), p 147 (Apr 1978)

Key Words: Noise reduction, Vibration control, Standards and codes

Measures agreed by the General Conference of the International Labour Office (ILO) to strengthen workman's protection against the hazards of air pollution, noise and vibration are set out in a consultive document published today by the Health and Safety Commission.

SURVEYS AND BIBLIOGRAPHIES

(See No. 1413)

MODAL ANALYSIS AND SYNTHESIS

(Also see No. 1512)

78-1374

A General Procedure for Substructure Coupling in Dynamic Analysis

C. Chang

Ph.D. Thesis, The Univ. of Texas at Austin, 141 pp (1977)

UM 7807276

Key Words: Component mode synthesis

In this thesis the various mode sets (normal modes, constraint modes, attachment modes and residual attachment modes) are defined. A new method which employs residual attachment modes is presented in detail and is shown to lead to results (e.g., system natural frequencies) comparable to, or better than those obtained by the other methods.

78-1375

On the Complex Normal Mode Analysis of Large Complex Systems Using Step-by-Step Interconnection of Subsystems

A. Youssefi

Ph.D. Thesis, Univ. of Cincinnati, 166 pp (1977)

UM 7803420

Key Words: Normal modes, Modal analysis

In this work the analysis of large complex systems is completed through the step-by-step interconnection of small and simple subsystems. The work is based on modal coordinate analysis for each subsystem as well as combined system by using transfer functions for connection points. In each step of analysis resonances, residues, and modal coordinates for the next connection points of the system are calculated. The modal coordinate analysis is completed for a general non-symmetric system and the concept of left-hand modal coordinates is used. A new form of dynamical matrix for determination of left-hand eigen-vectors is presented. The case where there is some multiplicity of resonances is discussed. Numerical techniques are used for determination of resonances in each step and a new first approximation to each resonance is presented.

78-1376

Improvement of Modal Methods for Dynamic Response Problems of Linear Elastic Structures

F. Kiessling

Inst. f. Aeroelastik, Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Goettingen, West Germany, Rept. No. ESA-TT-467, 41 pp (Aug 8, 1977)

(In German)

N78-18474

Key Words: Modal analysis, Vibration tests, Elastic analysis

In modal dynamic response computations of linear elastic structures global approximations were used for the neglected normal modes to get better results. The necessary input data can be obtained from vibration tests. The possible improvements were demonstrated by calculations on a continuum model and on a discrete model.

78-1377

Difficulties in Finding Modes Experimentally When Several Contribute to a Resonance

W. Soedel and M. Dhar

School of Mech. Engrg., Ray W. Herrick Labs., Purdue Univ., West Lafayette, IN 47907, J. Sound Vib., 58 (1), pp 27-38 (May 8, 1978) 9 figs, 1 table, 3 refs

Key Words: Modal analysis, Resonant response

For situations in which several modes may be contributing to a single resonance of a structure, a method for detecting the individual modes and for extracting useful information from the measurements is given. It is also shown that non-crossing of the experimental nodal curves may occur when modal resonant responses overlap because of finite damping, and again a method is presented that allows the extraction of useful results from measurements.

78-1378

Impedance of Acoustic and Structural Waveguides at Their Cutoff Frequencies

M.C. Junger

Cambridge Acoustical Associates, Inc., 1033 Massachusetts Ave., Cambridge, MA 02138, J. Acoust. Soc. Amer., 63 (4), pp 1206-1210 (Apr 1978) 11 refs

Key Words: Waveguide analysis

Two classes of waveguides are studied: acoustic waveguides conducting pressure waves generated by a constant-velocity source; and structural waveguides excited by a constant force shaker. The high-pass cutoff frequencies of propagating modes of both waveguide classes equal the natural frequencies of the corresponding standing-wave modes of the waveguide cross section. In acoustic waveguides, cutoff frequencies correspond to an infinite impedance at the source. In structural waveguides, cutoff frequencies coincide with vanishing drive-point impedance, the resonant mode short circuiting the other modes. This distinctive behavior is associated with the prescribed excitations and definition of drive-point impedance rather than with the nature of the waveguide.

COMPUTER PROGRAMS

GENERAL

78-1379

A Method for the Prediction of Noise Levels at Construction Site Boundaries

S. Hongo

Construction Method and Machinery Research Inst., SAE Paper No. 780471, 20 pp, 6 figs, 4 tables

Key Words: Computer programs, Noise prediction, Construction equipment

Prior to starting construction work in Japan, it recently has become necessary to predict the noise pollution level caused by construction equipment at the job site boundaries. This led to the development of a simple, inexpensive but relatively precise computer program and method for noise prediction. Input for the computer program requires measurement of the noise level of each machine used on the construction project. Accuracy of the method has been experimentally verified by field tests.

78-1380

ADAMS 2: A Sparse Matrix Approach to the Dynamic Simulation of Two-Dimensional Mechanical Systems

N. Orlandea, J.C. Wiley, and R. Wehage

Tech. Center, Deere & Company, SAE Paper No. 780486, 12 pp, 11 figs, 5 refs

Key Words: Computer programs, Matrix methods, Mechanical systems

An efficient computer program for general purpose dynamic simulation of two-dimensional mechanical systems named ADAMS 2 (Automatic Dynamic Analysis of Mechanical Systems, 2-Dimensional) is described. This program was developed along the same lines as the ADAMS [4] program for simulation of three-dimensional mechanical systems. For two-dimensional analysis this approach results in reduced execution time and storage requirements in comparison to specialized use of the 3D code.

78-1381

Design and Procurement Problems in the Gas Pipeline Industry

R.H. Pish

Southwest Research Inst., Combined Environments Technology Interrelations: Proc. 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 407-409 (Apr 18-20, 1978) 1 fig

Key Words: Sound level pressures, Computer programs, Industrial noise

A computer program AGA-SUM, developed in a study sponsored by the Pipeline Research Committee and the American Gas Association, provides a practical and easily used method for predicting the results of combining the sound levels from many pieces of equipment at a plant site. It is a digital program written in Fortran IV allowing entry in either English units (ft, mph, degrees F) or metric units (meters, km/hr, degrees C). The program applies correction factors for humidity, temperature and frequency to the normal radial decay of sound. In addition, the program can compute corrections for wind speed and direction.

78-1382

Method of Fan Sound Mode Structure Determination Computer Program User's Manual: Microphone Location Program

G.F. Pickett, R.A. Wells, and R.A. Love
Commercial Products Div., Pratt and Whitney Aircraft Group, East Hartford, CT, Rept. No. NASA-CR-135294; PWA-5554-4, 72 pp (Aug 1977)
N78-17065

Key Words: Fans, Noise measurement, Measurement techniques, Computer programs

A computer user's manual describing the operation and the essential features of the microphone location program is presented. The Microphone Location Program determines microphone locations that ensure accurate and stable results from the equation system used to calculate modal structures. As part of the computational procedure for the Microphone Location Program, a first-order measure of the stability of the equation system was indicated by a matrix 'conditioning' number.

78-1383

Theory and Computer Program for Transfer Function Identification by the GRAM Identifier with Application to Undersea Vehicles

V.K. Jain, G.J. Dobeck, and L.J. Lawdermilt
Univ. of South Florida, Tampa, FL, Rept. No. NCSL-TM-204-78, 106 pp (Feb 1978)
AD-A050 206/2GA

Key Words: Computer programs, Underwater structures, Dynamic response

A method for the analysis of submerged vehicle dynamics is described. It enables the test engineer to identify the transfer function parameters from actual flight-test data (for post-flight analysis), or from simulated trajectories (for designing tow-test maneuvers), via the computer program GRAM. The method is noniterative and yields reliable estimates in the presence of disturbances and instrumentation noise.

ENVIRONMENTS

ACOUSTIC

(Also see Nos. 1379, 1381, 1382, 1426, 1429, 1433, 1435, 1478, 1484)

78-1384

Effects of Acceleration on the Resonance Frequencies of Crystal Plates

P.C.Y. Lee, K. Wu, and Y.S. Wang
Dept. of Civil Engrg., Princeton Univ., Princeton, NJ 08540, J. Acoust. Soc. Amer., 63 (4), pp 1039-1047 (Apr 1978) 9 figs, 18 refs

Key Words: Plates, Resonators, Resonant frequencies, Flexural vibration

The changes in the thickness-shear resonance frequencies of circular crystal plates subjected to steady in-plane acceleration of arbitrary direction are studied. A closed-form solution for a circular plate under acceleration with three or more points of mounting is obtained. From this solution, initial stress and strain fields are computed at each and every point of the plate as a function of plate orientation, direction of acceleration, and positions of supports.

78-1385

The Construction of Solutions to Acoustic Scattering Problems in a Spherically Stratified Medium

D. Colton and R. Kress
Dept. of Mathematics, Univ. of Strathclyde, Glasgow, UK, Quart. J. Mech. Appl. Math., 31 (1), pp 9-17 (Feb 1978) 8 refs

Key Words: Acoustic waves, Wave diffraction

The problem of the scattering of acoustic waves by a spherically stratified inhomogeneous medium is considered. The approach is based on a new representation for solutions to the reduced wave equation in a spherically stratified medium. For small values of the wave number of Born approximation is recovered, whereas approximation methods can also be obtained for larger values of the wave number where the Born approximation may no longer be valid.

78-1386

The Scattering of Surface Waves by Compact Obstacles

A.M.J. Davis and F.G. Leppington
Dept. of Mathematics, Univ. College, London, UK,
Quart. J. Mech. Appl. Math., 31 (1), pp 19-30 (Feb 1978) 1 fig, 4 refs

Key Words: Acoustic waves, Wave diffraction

A regular wave train travels along the surface of a body of slightly compressible fluid of infinite depth or constant depth, and is scattered by totally immersed obstacles. The scattering geometry may be either two- or three-dimensional, but is taken to be compact in the sense that the ratio ϵ, of characteristic width against depth, is small. An asymptotic solution is found in the limit $\epsilon \to 0$ using the method of matched expansions, in which a locally incompressible inner approximation is matched with an outer solution that corresponds to point- or line-source singularities. A general treatment is developed and explicit results are given for the surface waves scattered by either a pair of circular cylinders or by a prolate spheroid at incidence.

78-1387

Diffraction of Sound Pulses and Acoustic Emission in a Hollow Elastic Cylinder

P. Chen
Ph.D. Thesis, Cornell Univ., 182 pp (1978)
UM 7809463

Key Words: Sound propagation, Cylindrical shells, Cavity containing media, Acoustic scattering, Non-destructive tests

The propagation of sound pulses in a thick-walled circular cylinder is analyzed by applying the technique of integral transforms. The transient waves are generated by a line source parallel to the axis of the cylinder, and are reflected and diffracted by both cylindrical surfaces. The multiple reflected pulses are represented by generalized ray integrals, each of which represents a pulse traveling along a specific ray path, and the inverse transforms of these ray integrals are evaluated by a modified Cagniard's method developed in the thesis. This analysis provides a theoretical basis for acoustic emission which has been recently developed as a non-destructive testing technique to monitor the safety and integrity of structures, and to predict the fracture and failure of materials. This technique is similar to the passive sonar system in underwater acoustic.

78-1388

Modelling as a Means to Assess Noise Impact

C.R. Foster
Office of Environmental Quality, Federal Aviation Admin., Dept. of Transportation,
SAE Paper No. 780563, 12 pp, 6 figs, 1 table

Key Words: Mathematical models, Aircraft noise

The Department of Transportation/Federal Aviation Administration has developed a valuable noise-simulation computerized tool for describing and defining the impact of aircraft noise around an airport. This tool, the integrated noise model, became available to the public in 1977, and is useful in assessing actual or predicted airport noise impacts. The model takes into account all pertinent impact parameters including types and numbers of aircraft operating at the airport, flight tracks, operating procedures, and time of day of aircraft operations. This paper will familiarize the reader with the capabilities and characteristics of the integrated noise model.

78-1389

On the Application of Acoustic "Mirror", "Telescope" and "Polar Correlation" Techniques to Jet Noise Source Location

H.V. Fuchs
Deutsch Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt e.V., Institut f. Turbulenzforschung, 1000 Berlin 12, Germany,
J. Sound Vib., 58 (1), pp 117-126 (May 8, 1978) 1 fig, 11 refs

Key Words: Noise source identification, Jet noise

Jet noise source identification and location is still an important issue since no really conclusive or generally accepted description of the noise generation processes in turbulent jets has been given to date. There are not only limitations in the spatial resolution which restrict these techniques to jet noise at the higher Strouhal and Mach numbers but also more fundamental difficulties in the interpretation of measured equivalent source strength density distributions. In particular, if large scale coherent turbulence structures participate in jet noise generation the assumption of a uniform amplitude and phase of the pressure field radiated from compact elements of this distribution is questionable.

78-1390

Underwater Sound Wave Propagation in the Presence of a Randomly Perturbed Sound Speed Profile. Part I

I.M. Besieris and W.E. Kohler
Dept. of Electrical Engrg., Virginia Polytechnic Inst. and State Univ., Blacksburg, VA 24061,
SIAM J. Appl. Math., 34 (3), pp 423-436 (May 1978) 13 refs

Key Words: Underwater sound transmission

Time-harmonic acoustic wave propagation is considered in the presence of a spatially and temporally randomly perturbed parabolic profile. A scaling based on typical ocean environments is introduced. A transport equation governing the space-time evolution of the correlation function of the complex pressure is derived. Finally, the theory is illustrated by considering an approximate solution in one special case.

78-1391

Acoustic Transmission Through Orthotropic Multilayered Plates. Part II: Transmission Loss

J.L. Guyader and C. Lesueur

Vibration-Acoustic Lab. of the National Inst. of Applied Sciences, 69621 Villeurbanne Cedex, France, J. Sound Vib., 58 (1), pp 69-86 (May 8, 1978) 8 figs, 1 table, 23 refs

Key Words: Sound transmission loss, Plates, Layered materials

An expression for the transmission loss by finite, viscoelastic and othrotropic multilayered plates, is presented. It is based on the development of a method to calculate the transmission loss based on a combination of statistical and deterministic approaches, and on the determination of vibration modes of orthotropic multilayered plates (Part I). Numerical computations of the transmission loss show the influences of the main parameters and a type of light high insulation panel is thereby determined. Lastly a comparison of theoretical and experimental results is made.

78-1392

Measurement of Acoustic Reflection From an Obstruction in a Pipe with Flow

J.P. Johnston and W.E. Schmidt

Thermosciences Div., Dept. of Mech. Engrg., Stanford Univ., Stanford, CA 94305, J. Acoust. Soc. Amer., 63 (5), pp 1455-1460 (May 1978) 5 figs, 6 refs

Key Words: Acoustic reflection, Ducts, Pipes (tubes)

An alternative to the impedance tube method is proposed for measurement of acoustic reflection coefficients. The new method has the advantage that it may be used to measure the reflection and transmission coefficients for plane sound waves incident on an obstruction (orifice, nozzle, valve, elbow, etc.) in a long, straight, hard-walled duct in the presence of flow through the duct. It employs the time-delayed cross correlation between an acoustic signal source and the output signals from microphones located ahead of, and behind, the obstruction. The method is demonstrated for several situations, including the case of flow through square-edged orifices where Mach number in the jet downstream of one orifice was as high as 0.73.

78-1393

Six Elements in Plant Noise Control

J. Joiner

Joiner-Pelton-Rose, Inc., Dallas, TX, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 403-406 (Apr 18-20, 1978)

Key Words: Industrial facilities, Noise control

Six of the more popular methods used to reduce noise from a source before reaching a receiver are discussed. They are distance, orientation, barriers, absorption, enclosures, and mufflers.

78-1394

Noise and Exhaust Gas Pollution Caused by Engines in Small- and Medium-Sized Construction Equipment in Japan

T. Azuma and N. Nakato

Diesel Engine Committee of J.C.M.A., SAE Paper No. 780490, 16 pp, 3 figs, 11 tables

Key Words: Construction equipment, Noise generation

In regards to construction equipment, there has been a rapid increase in the number of civil engineering projects undertaken in urban areas over the last ten years. Thus, necessitating further consideration of the pollution problem. Noise and vibration pollution account for a high rate (34%) of construction pollution. In regards to exhaust gas, countermeasures, different from those used against motor vehicles, were put forth to protect the health of the workers. This paper refers to current anti-pollution regulations, user needs, and countermeasures against noise and exhaust pollution, and also includes future problems.

78-1395

Responses to Air-Conditioning System Noise

N.W.M. Ko, W.F. Ho, and W.K. Un

Dept. of Mech. Engrg., Univ. of Hong Kong, Hong Kong, J. Sound Vib., 57 (4), pp 595-602 (Apr 22, 1978) 6 figs, 5 tables, 13 refs

Key Words: Air conditioning equipment, Noise generation, Human response

A pilot study on the subjective responses of 200 Chinese to air-conditioning system noise has been carried out. Coupled with the acoustic measurements of the systems and of the background, the annoyance response was found to correlate well with the difference in the source level and the intermittent background level and with an index similar to the Noise Pollution Level. The arousal, however, did not correlate as well with the above noise indices.

78-1396

Surface Transportation Noise -- The Role of the U.S. Department of Transportation

W.H. Close

Office of Noise Abatement, U.S. Dept. of Transportation, Washington, D.C., SAE Paper No. 780-383, 8 pp

Key Words: Traffic noise, Noise reduction

The U.S. Department of Transportation plays a variety of roles in the area of surface transportation noise abatement and control. This paper outlines these roles through a discussion of the research, development, and demonstration programs and accomplishments of the various Departmental organizations, including: The Federal Highway Administration, the National Highway Traffic Safety Administration, the Federal Railroad Administration, the Urban Mass Transportation Administration, the U.S. Coast Guard, and the Office of the Secretary of Transportation.

PERIODIC

78-1397

Response of Periodic Structures

R.C. Engels

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 177 pp (1977)

UM 7808116

Key Words: Periodic structures, Harmonic excitation, Perturbation theory, Modal analysis

Periodic structures are defined as structures consisting of identical substructures connected to each other in identical manner. The response of periodic structures to harmonic excitation is described by a matrix difference equation. Finite periodic structures are considered for different types of loading. The problem of almost periodic structures is considered. If the system parameters differ slightly from one substructure to another, then the structure becomes almost periodic. An efficient method using a perturbation technique to derive the response of an almost periodic structure is presented. The undamped response of a periodic structure using a modal analysis technique is considered. The method allows for arbitrary loads and takes full advantage of the periodic properties of the structure. An attempt is made to simulate certain continuous systems by periodic structures.

RANDOM

(See No. 1427)

78-1398

The Effect of Simultaneous Vibration and Electromagnetic Radiation on Shielding by Conductive Gaskets

C.H. Kuist

Chomerics, Inc., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 472-476 (Apr 18-20, 1978) 4 tables

Key Words: Electromagnetic shielding, Elastomers, Vibration effects

Vibration induces changes in conductive powder filled elastomers. These changes result in decreased effectiveness of shielding when gaskets are subjected to a combined environment of vibration and electromagnetic radiation. The experimental results reported here confirm earlier studies in showing that the shielding performance of smooth spherical filler gaskets is degraded more severely than that of very rough surfaced irregular shaped agglomerates.

SEISMIC

(Also see No. 1455)

78-1399

Significance of Seismic Response Spectrum Normalization in Nuclear Power Plant Design

J.S. Dalal and P.R. Perumalswami

Structural Analysis Group, United Engineers and Constructors, Inc., 30 S. 17th St., Philadelphia, PA 19101, Nucl. Engr. Des., 47 (1), pp 145-156 (May 1978) 7 figs, 3 tables, 11 refs

Key Words: Nuclear power plants, Seismic design

Peak ground acceleration has been used most commonly to normalize seismic response spectra. Apparently, there is a general consensus that this is not the best parameter for spectrum normalization. Several other parameters have been proposed, such as, peak acceleration - velocity - displacement triad, peak velocity and spectrum intensity. This paper presents statistical studies of response spectra from a number of recorded earthquake motions normalized by several different parameters.

78-1400

Modeling of Slabs in Seismic Analysis of Nuclear Power Plant Buildings

P.R. Perumalswami and J.S. Dalal

Structural Analysis Group, United Engineers and Constructors, Inc., 30 S. 17th St., Philadelphia, PA 19101, Nucl. Engr. Des., 47 (1), pp 135-143 (May 1978) 19 figs, 2 tables, 5 refs

Key Words: Nuclear power plants, Seismic response, Mathematical models

Safety related nuclear power plant buildings are commonly represented as lumped mass weightless elastic beam stick models to determine their dynamic behavior under seismic ground motions. Implicit in this analysis procedure is the assumption that the floor slabs are rigid. This paper critically evaluates the slab flexibilities in typical power plant buildings and presents a practical approach to include these in the seismic analysis. Vertical as well as horizontal earthquake components are considered. Results presented include amplified floor response spectra for equipment qualification and design forces in floor slabs and the supporting walls. A satisfactory analysis procedure would consist of traditional stick model analysis to obtain overall seismic responses, force distribution by static analysis using suitable methods such as the finite element method and subsystem analysis to evaluate local amplifications, if necessary.

78-1401

A Simplified Procedure for Estimating Earthquake-Induced Deformations in Dams and Embankments

F.I. Makdisi and H.B. Seed

Earthquake Engrg. Res. Center, California Univ., Richmond, CA, Rept. No. UCB/EERC-77/19, 68 pp (Aug 1977)

PB-276 820/8GA

Key Words: Dams, Earthquake response

The inadequacy of the pseudo-static approach recommended by the International Committee on Large Dams, to predict the behavior of low embankments during earthquakes has been clearly recognized and demonstrated. The committee pointed out the need for early revision of the method which 'in several instances...predicts a safe condition for dams which are known to have had major slides.' This report presents a simplified procedure for the seismic design of small embankments. The method is an approximate one which uses the concept, originally proposed by Newmark, for calculating permanent deformations, but it is based on an evaluation of the dynamic response of the embankment rather than rigid body behavior. The method is applied to dams with heights in the range of 100 to 200 ft and constructed of compacted cohesive soils or very dense cohesionless soils. Design curves on the basis of analyzed cases are presented with an example problem. The method is an approximate one and involves simplifying assumptions.

78-1402

Los Angeles Reservoir is Safe from Earthquakes

Civil Engrg. (N.Y.), 48 (6), pp 88-89 (June 1978) 2 figs, 1 table

Key Words: Earthquake resistant structures, Dams

Earthquake resistant design and construction of the Los Angeles reservoir is described. It is impounded behind a new earthfill dam and provides much-needed regulatory and emergency storage for water supply to Los Angeles. Dynamic finite element method analysis showed the dam can withstand even the most severe earthquake and still retain the water behind it.

78-1403

The Performance of Earth Dams During Earthquakes

H.B. Seed, F.I. Makdisi, and P. de Alba

Earthquake Engineering Res. Center, California Univ., Richmond, CA, Rept. No. UCB/EERC-77/20, 58 pp (Aug 1977)

PB-276 821/6GA

Key Words: Dams, Earthquake response

In the design of embankments against earthquakes in addition to the proper use and understanding of the material properties and behavior during seismic loading, and in addition to the proper use of analytical procedures to estimate the dynamic response, considerable insight and judgment are required. This can only be gained through an intimate knowledge of the strengths and limitations of the analysis and testing procedures themselves, and by studying the behavior of similar embankments during actual earthquake loading conditions. The purpose of this report is to summarize available information concerning the behavior of dams subjected to strong earthquake shaking. The report is intended to complement an initial review by Ambraseys (1960) by presenting further details concerning embankment construction materials and procedures and performance records in earthquakes during the past 17 years. The salient features of observed embankment performance are summarized, mainly for six major earthquakes, and conclusions are drawn which may aid the design engineer in making more meaningful evaluations of the data provided by analytical design procedures.

78-1404

A Practical Soft Story Earthquake Isolation System

J.M. Kelly, J.M. Eidinger, and C.J. Derham
Earthquake Engrg. Res. Center, California Univ., Richmond, CA, Rept. No. UCB/EERC-77/27, 150 pp (Nov 1977)
PB-276 814/1GA

Key Words: Earthquake resistant structures, Energy absorption, Rubber, Isolators

This report describes the experimental and analytical results of a practical earthquake isolation system. The experimental work was carried out using a 20 ton three-story single-bay moment-resistant steel frame structure on the 20 by 20 foot shaking table at the Earthquake Engineering Research Center at the University of California, Berkeley. The soft story isolation system is composed of elastic natural rubber bearings and a highly nonlinear energy-absorbing device, all placed beneath the base floor of the model structure. The bearings allow for lateral movement of the base of the model and are designed so that no adverse column P-delta effects can occur. The energy-absorbing devices act as highly efficient dampers, and are based upon the two-way plastic torsion of steel bars. For smaller earthquakes, the structure behaves as with a rigid foundation.

78-1405

Rubber Springs Reduce Earthquake Forces

Noise Control Vib. Isolation, 9 (4), p 146 (Apr 1978) 2 figs

Key Words: Seismic design, Buildings, Springs (elastic), Elastomers

A new protective system, which for some structures can reduce the forces experienced during an earthquake by a factor of 10, announced by a group of scientists from the University of California and the Malaysian Rubber Producers' Research Association is described.

SHOCK

(Also see Nos. 1430, 1473, 1514)

78-1406

A Summary of Ship Deck Motion Dynamics as Applied to VSTOL Aircraft

A.E. Baitis
Naval Postgraduate School, Monterey, CA, In: Proc. of the Navy/NASA VSTOL Flying Qualities, pp 407-460 (Aug 1977)
N78-19116

Key Words: Ships, Aircraft, Landing, Impact shock

Ship deck motions are considered in terms of the landing/takeoff of V/STOL aircraft from small ships. Fluctuations in the air turbulence shed by the ship's superstructures, wind direction and velocity, and wind turbulence loads on the aircraft are among the factors discussed. Roll stabilization using antiroll tanks, fins, and rudders is covered.

78-1407

On Impactor Synthesis

B. Lundberg and M. Lesser
Dept. of Mech. Engrg., Univ. of Lulea, S-95187, Lulea, Sweden, J. Sound Vib., 58 (1), pp 5-14 (May 8, 1978) 5 figs, 9 refs

Key Words: Structural synthesis, Impact response (mechanical)

A method for synthesizing non-uniform, linearly elastic impactors which generate given impact forces on given targets is presented. The impactors are assumed to obey Webster's equation, and the targets are assumed to be linear with time-invariant properties. The method is illustrated by solving two synthesis problems concerned with the generation of exponential and ramp impact loads. The results are verified by solving the corresponding analysis problems.

78-1408

Response of Equipment to Aircraft Impact

J.P. Wolf, K.M. Bucher, and P.E. Skrikerud
Electrowatt Engrg. Services, Ltd., Bellerivestrasse 36, P.O. Box 8022, Zurich, Switzerland, Nucl. Engr. Des., 47 (1), pp 69-193 (May 1978) 44 figs, 2 tables, 13 refs

Key Words: Nuclear power plants, Shock-resistant design, Crash research (aircraft)

After discussing the state of the art of the development of equivalent force-time relationships for aircraft impact, the results of the so-called Riera model and of a lumped-mass model are compared for rigid and deformable targets. The importance of adequate modeling of structures to enable the calculation of response spectra also in the high-frequency range is demonstrated using a typical reactor shield building and a reactor auxiliary building. For an adequate model, the influence of the aircraft-structure interaction, of the material interaction, of the material nonlinearly, of the damping and of the mass on the response of equipment is examined.

78-1409

Volkswagen's Passive Seat Belt/Knee Bolster Restraint, VWRA -- A Preliminary Field Performance Evaluation -- Progress Report

S.R. Miller, U.W. Seiffert, and J.D. States

Research and Dev., Volkswagenwerk AG, Wolfsburg, Germany, SAE Paper No. 780436, 16 pp, 23 figs, 5 tables, 3 refs

Key Words: Safety restraint systems, Collision research (automotive)

This paper describes results of the field accident performance of the VW Passive Restraint System (VWRA) installed in Rabbit vehicles operating on U.S. highways. The historical development of the VWRA as an outgrowth of VW's research and development programs is detailed for perspective. To act as a baseline, dynamic sled and full-scale barrier crash testing with instrumented surrogates using the VWRA are presented. The primary portion of the paper deals with collected and calculated data from VW's field investigations which have been in progress over the last two years.

78-1410

Statistics of Amplitude and Spectrum of Blasts Propagated in the Atmosphere

P.D. Schomer, R.J. Goff, and L.M. Little

The Construction Engrg. Res. Lab., Champaign, IL 61820, J. Acoust. Soc. Amer., 63 (5), pp 1431-1443 (May 1978) 15 figs, 2 tables, 8 refs

Key Words: Shock wave propagation, Statistical analysis

This paper describes the measurement and analysis of over 11,000 blast recordings. These data are used to develop a statistical base for blast propagation and to establish one-third octave spectra for these blasts. These results can then be used to predict community blast noise levels. The blasts are divided into rather broad amplitude groupings and it is shown that received blast spectra are dependent only on grouping and not on absolute peak amplitude or distance (2-15 miles).

TRANSPORTATION

(See No. 1396)

PHENOMENOLOGY

DAMPING

(Also see No. 1472)

78-1411

An Introduction to the Problem of Dynamic Structural Damping

P. Santini, A. Castellani, and A. Nappi

AGARD, Neuilly-Sur-Seine, France, Rept. No. AGARD-R-663, 27 pp (Jan 1978)

AD-A050 279/9GA

Key Words: Structural members, Damping

Some of the major topics in the area of dynamic damping are described. A list of typical problems where damping is of primary importance is listed. Typical structural components are considered, and a brief account on the effect of materials is given. Mathematical models and intermodal coupling is also examined, and the extreme difficulty to have reasonably accurate information from them is emphasized. Possible philosophies of ground tests and flight tests are discussed.

FLUID

(Also see Nos. 1460, 1485)

78-1412

A Universal Strouhal Number for the 'Locking-On' of Vortex Shedding to the Vibrations of Bluff Cylinders

O.M. Griffin

Ocean Tech. Div., Naval Reserach Lab., Washington, D.C. 20375, J. Fluid Mech., 85 (3), pp 591-606 (1978) 8 figs, 3 tables, 29 refs

Key Words: Cylinders, Fluid-induced excitation

This paper presents a model for a universal wake Strouhal number, valid in the subcritical range of Reynolds numbers, for both forced and vortex-excited oscillations in the locking-on regime. The Strouhal numbers thus obtained are constant over the range of wake Reynolds numbers. A correspondence between the amplification of the cylinder base pressure, drag and vortex circulation is demonstrated over a wide range of frequencies and for vibration amplitudes up to a full cylinder diameter (peak to peak).

EXPERIMENTATION

DIAGNOSTICS

(Also see No. 1387)

78-1413

A Review of Mechanical Signature Analysis

R.H. Volin

Naval Research Lab., Washington, D.C. 20375, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 357-362 (Apr 18-20, 1978) 62 refs

Key Words: Reviews, Vibration signatures, Standards and codes, Measuring instruments, Data processing, Bearings, Gears

The literature on the use of vibration signatures for monitoring the condition of machinery and its components is reviewed. The literature discussed falls under the following topics: criteria and standards, instruments and measurements, data processing, bearings and gears, turbomachinery, vehicles, quality assurance, and field experience.

78-1414

Computer-Managed Monitoring of Plant Machinery - Part 1 and 2

J. Bozich

Digital Systems Group, Spectral Dynamics Corp., Noise Control Vib. Analysis, 9 (3), pp 99-101 (Mar 1978) 5 figs, and 9 (4), pp 137-142 (Apr 1978) 5 figs, 2 refs

Key Words: Diagnostic techniques, Computer aided techniques

A computer-managed plant monitoring system is described. Its primary feature is consistent and continuous monitoring of the analysis of measurements on all critical rotating machinery trains. The system performs all data-processing, filing, up-dating and presentation chores, freeing manpower for other tasks. The system has a full-time self-diagnosing feature, which is also continuously monitored to validate the system's 'health', essentially eliminating false alerts due to system malfunctions and/or failures.

78-1415

Safeguarding the Health of Machinery: Plant Condition Monitoring in a Chemical Works

E.L. Hipkin and A. Heimann

Albright & Wilson, Ltd., Noise Control Vib. Isolation, 9 (4), pp 127-219 (Apr 1978) 1 fig, 2 tables

Key Words: Diagnostic techniques

Three techniques of machinery health monitoring in chemical industry are discussed. They are ultrasonic corrosion monitoring of pipe work and vessels; contamination analysis of lubricating oils; and vibration monitoring and analysis of rotating and reciprocating machines. Other techniques - thermography, acoustic emission and ultrasonic flaw detection amongst them - are available for more specialized needs.

78-1416

A Practical Vibration Primer. Part 8 - Vibration Severity

C. Jackson

Monsanto Chemical Intermediate Co., Texas City, TX, Hydrocarbon Processing, 57 (4), pp 209-215 (Apr 1978) 15 figs, 5 refs

Key Words: Vibration severity, Diagnostic techniques, Balancing techniques

The author describes a number of vibration severity charts including their applications and limitations. In some detail, he discusses gearing vibrations and their monitoring. The article closes with a discussion of a balancing severity concept and a method for the calculation of residual unbalance.

78-1417

Prototype of Bispectral Passive Imaging Systems Aiming Machine-System Diagnosis

T. Sato, K. Sasaki, and M. Nonaka

Faculty of Science and Engrg., Tokyo Inst. of Tech., 4259 Nagatsuda, Midori-ku, Yokohama-shi, Japan, J. Acoust. Soc. Amer., 63 (5), pp 1611-1616 (May 1978) 8 figs, 1 table, 7 refs

Key Words: Diagnostic techniques, Machinery, Test equipment

A prototype of bispectral passive imaging system designed for the diagnosis of machine systems from their noises is presented. The principle is generalized aiming machine-system diagnosis and the concrete construction of scanner of a microphone and the details of the signal processings as well as the obtained images are shown. Typical characteristics of the system are as follows: images to be reconstructed, spatial distribution of the degree of interference among three frequency components or spatial distribution of intensity of noise emitted from the object; maximum resolution; time required to obtain one image, from 30 to 90 min depending on the number of sampling points; display of result, print out on a typewriter or colored display on a TV monitor.

78-1418

Diagnostic System Requirements for Helicopter Propulsion Systems

J.A. Murphy

Bell Helicopter Textron, Fort Worth, TX, J. Aircraft, 15 (6), pp 333-338 (June 1978) 3 figs, 4 tables, 6 refs

Key Words: Helicopters, Diagnostic techniques

Automatic diagnostic systems have proven effective in reducing accidents, maintenance costs, and operating costs associated with turbine powered equipment. Current diagnostic applications are generally limited to large aircraft and stationary power plants due to high initial cost. A need exists for a simple low-cost diagnostic system for general aviation category aircraft. This is especially true for helicopters due to their complex propulsion systems and frequent deployment with minimal crew into remote locations. Recent advances in electronic technology make such a system feasible; however, the system must be carefully tailored to the requirements of the user. One such set of general requirements is presented, together with supporting rationale, from the viewpoint of a helicopter manufacturer. A conceptual diagnostic system design which meets these requirements in included.

EQUIPMENT

78-1419

Control of a Single-Actuator Shaking Table

S. Abedi-Hayati and D. Auslander

Arya Mehr Univ. of Tech., Tehran, Iran, ASME Paper No. 77-WA/Aut-11

Key Words: Shakers, Algorithms, Simulation

A control algorithm for reproducing a desired acceleration time history by single actuator shaking tables is developed. It is shown that the actuator control may be specified independent of the test specimens. Some simulation studies are carried out to test the effectiveness of the algorithm and to compare this method with another currently used method.

78-1420

A Central Switching System for Vibration Test Equipment

J.L. Frye

Ling Electronics, Inc., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 82-87 (Apr 18-20, 1978) 6 figs

Key Words: Test equipment, Vibration tests, Control equipment

Maximum utilization of the vibration test equipment in a facility is possible by the addition of a properly designed switching system. This paper discusses the advantages of adding a switching system to a facility and outlines the design criteria required. Interlocking and safety provisions are discussed. Several complex systems are presently is operation. One such system is presented in block diagram form.

78-1421

An Approach to Multi-Shaker CERT Testing Using Digital Control

E.A. Andress

Spectral Dynamics Corp., San Diego, CA, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 348-351 (Apr 18-20, 1978) 7 figs, 2 tables

Key Words: Test equipment, Vibration tests, Control equipment

An approach is available to the testing industry which provides most of the desirable performance capabilities of modern digital control systems for multi-station shaker control. Costs per station are close to those of manual systems thus providing a cost effective method of meeting combined environment reliability testing requirements for high volume test throughout.

78-1422
Multiple Shaker Random Control with Cross Coupling
D.O. Smallwood
Sandia Laboratories, Albuquerque, NM 87115, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 341-347 (Apr 18-20, 1978) 9 figs, 9 refs

Key Words: Test equipment, Vibration tests, Control equipment

The report develops an algorithm for a multiple shaker random vibration control system. The method allows for cross-coupled mechanical systems with partially coherent inputs. The method also includes time domain randomization of the drive signals to provide a true random control system output.

78-1423
Multipower Amplifier Utilization for Pyroshock Simulation on an Electro Dynamic Exciter
C.R. Yorio and G.M. Lester
The Perkin-Elmer Corp., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 377-379 (Apr 18-20, 1978) 3 figs, 4 refs

Key Words: Test equipment, Vibration tests

This paper describes the amplifier modifications, switching techniques and preliminary test results of using one, two and four power amplifiers wired in series/parallel configurations to increase the force capabilities of a single exciter shock setup. System switching block diagrams, schematics and power amplifier modifications and configurations are presented for a MB Electronics C-150 exciter/4450 amplifier system.

78-1424
Shock Performance Factors of a Digitally Controlled Shaker/Amplifier System
F.M. Tillou
Ling Electronics, Inc., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 333-340 (Apr 18-20, 1978) 6 figs, 4 refs

Key Words: Test equipment, Shock tests, Control equipment

This paper discusses those characteristics of control systems, power amplifiers, and shakers that determine the maximum performance obtainable with a given system for shock time history and shock spectrum testing. Analog and digital pulse synthesis methods are described, along with such factors as wavelet types, pulse durations, response/input acceleration ratios, etc. Solid state power amplifiers are compared to previous vacuum tube versions with respect to transient performance factors such as peak instantaneous voltage and current, safe operating area, etc. Shaker characteristics such as peak stroke, maximum allowable terminal velocity, maximum acceleration, power requirements and bandwidth are discussed. A system shock performance rating method is presented which includes the above factors as well as test item mass and impedance matching requirements.

78-1425
Pulse Applications and Parameter Identification for U.S. Navy Medium-Weight Shock Machine
F.B. Safford
Agbabian Associates, El Segundo, CA, Rept. No. NRL-MR-3657, AD-E000 083, 45 pp (Nov 1977) AD-A050 120/5GA

Key Words: Shock tests, Test equipment, Pulse excitation, Parameter identification technique

The scope of this study covers the following two objectives: Provide the design for a mechanical-force pulse generator, specify associated hydraulic power unit and controls, and provide pulse-train profiles and mandrels; and perform an exploratory parametric identification study of the U.S. Navy medium-weight shock machine, test article, and impact loads using NRL-furnished data.

FACILITIES

78-1426
Acoustic Environment Testing
W. Tustin
Tustin Inst. of Tech., Inc., Santa Barbara, CA, S/V, Sound Vib., 12 (4), pp 24-27 (Apr 1978) 3 figs, 23 refs

Key Words: Test facilities, Acoustic tests, Equipment response, Airborne equipment response

The hazard of intense noise as it adversely affects equipment aboard missiles and aricraft, as well as the vehicles themselves, is examined. Intense noise is simualted in specially equipped laboratories. Test specifications are referenced and a few test systems are described.

78-1427

Quasi-Random Vibration Effects on Enclosure Electromagnetic Radiation Shielding Effectiveness

D.H. Simons and A.L. Lena

Hughes Aircraft Co., Culver City, CA, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 455-465 (Apr 18-20, 1978) 6 figs, 3 refs

Key Words: Enclosures, Electromagnetic shielding, Electronic instrumentation, Vibration effects

A quasirandom vibration facility was designed to test if the electromagnetic shielding effectiveness of an enclosure of an electronic system is degraded by vibration. The paper discusses major test facility components, test performance, and test results.

INSTRUMENTATION

78-1428

An Introduction to the Measurement of Equivalent Continuous Noise Levels Leq

R. Norgan

Computer Engineering, Ltd., Noise Control Vib. Isolation, 9 (4), pp 143-145 (Apr 1978) 3 figs

Key Words: Noise measurement, Measuring instruments, Sound level meters

Characteristics and operation of equivalent continuous noise level (Leq) meters are described. They are much more complicated than the normal sound level meter and are consequently more expensive, but they do measure Leq accurately and easily under any conditions.

SCALING AND MODELING

(Also see No. 1514)

78-1429

A Simplified Mach Number Scaling Law for Helicopter Rotor Noise

K.S. Aravamudan, A. Lee, and W.L. Harris

Dept. of Aeronautics and Astronautics, Massachusetts Inst. of Tech., Cambridge, MA 02139, J. Sound Vib., 57 (4), pp 555-570 (Apr 22, 1978) 15 figs, 15 refs

Sponsored by the U.S. Army Res. Office and NASA

Key Words: Scaling, Helicopter rotors, Noise generation

A simplified Mach number scaling law is obtained for rotational and high frequency broadband noise from helicopter rotors. These scaling laws are based on geometric parameters of the rotor. A comparison of the peak frequency location of high frequency broadband noise for full scale rotors obtained by Leverton was made, with the predicted Strouhal frequency parameter being used, and the agreement was found to be highly favorable.

TECHNIQUES

(Also see Nos. 1387, 1500)

78-1430

Shock-Wave Impedance Match at Low Pressures

M. Avinor, Z. Rosenberg, and Y. Oved

Ministry of Defence ADA, P.O. Box 2250, Haifa, Israel, J. Phys. E. (Sci. Instr.), 11 (4), pp 300-301 (1978) 6 figs, 2 refs

Key Words: Shock wave propagation, Measurement technique

A new method has been developed for precision shock-wave impedance match at low pressures. The method consists of sending a diverging, spherical shock front through a stack of metal plates separated by thin layers of insulation. The successive electrical shorts measure the shock-wave velocity and decay. By making the stack of two different materials the shock-wave velocity can be extrapolated from each side to the interface to give precise values for use in impedance matching.

78-1431

Protection of the Test Article in the Vibration Laboratory

F.R. Barlett

Ling Electronics, Inc., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 363-367 (Apr 18-20, 1978) 6 figs

Key Words: Vibration tests, Testing techniques

Simulation of the vibration environment in the laboratory involves subjecting the test article to a predetermined test profile while monitoring its performance either actively or passively. A valid test requires that the test article is neither undertested or overtested. This paper reviews the nature of the potential hazards and emphasizes the use of simple basic safety techniques.

78-1432

The Perils and Pitfalls of Low-Cost Vibration Alternatives Practical Experience with Pneumatic Exciters for Production Screening

H. Caruso

Westinghouse Electric Corp., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 66-69 (Apr 18-20, 1978) 5 refs

Key Words: Testing techniques, Pneumatic tools, Electronic instrumentation

The paper summarizes essential conditions and considerations in the application of pneumatic vibrators to the in-line evaluation of electronic equipment.

78-1433

Analog Tape Microsampling for 24-Hour Noise Source Identification and Analysis

H. Watson, Jr. and R.M. Sheikh

Southern Methodist Univ., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 398-402 (Apr 18-20, 1978) 5 tables

Key Words: Measurement techniques, Noise source identification, Equivalent sound levels, Aircraft noise

In this research program, microsampling methods to be used for source identification and noise level statistics were investigated. The results of a study of aricraft/airport noise are illustrated. There is no universal microsampling method for all source environments; however, the Demand-Periodic and Demand-Random methods have proved to be the best overall for all methods and sources studied.

78-1434

A 24 Channel Acoustic/Vibration Test Power Amplifier

F.R. Barlett

Ling Electronics, Inc., Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 372-376 (Apr 18-20, 1978) 6 figs, 5 tables, 3 refs

Key Words: Vibration tests, Acoustic tests, Testing techniques

This paper examines the advantages and disadvantages of a multichannel amplifier as used in a vibration or acoustic facility. The compromises arrived at in one case are presented.

78-1435

Feasibility of Using Coupled Reverberant Chambers for Measurement of Sound Power

Y.F. Hwang

Vought Corp., Dallas, TX, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 368-371 (Apr 18-20, 1978) 2 figs, 14 refs

Key Words: Sound measurement, Measurement techniques

The use of two adjacent rooms coupled with an open window for sound power measurement is presented. The method is focused on the best utilization of moving sound diffusers, and thereby reducing the difficulties encountered in the measurement of sound sources with low discrete-frequency components.

COMPONENTS

SHAFTS

78-1436

Contributions from a Study of the Dynamics of Rotating Straight Shafts of Changing Noncircular Cross Sections (Contribution A L'Etude Dynamique Des Arbres Droits a Section Non Circulaire Charges Par Un Rotor en Leur Milieu)

A. Ripianu

Institut Polytechnique de Cluj-Napoca, J. de Me-

canique Appl., 22 (4), pp 537-553 (1977) 11 figs, 7 refs
(In French)

Key Words: Shafts, Variable cross section

This paper describes work on the influence of external resisting forces and internal friction forces on the movement of straight rotating shafts with internal noncircular cross sections.

78-1437

Frequency Analysis of Multi-Span Shafts

S. Mahalingam

Dept. of Mech. Engrg., Univ. of Sri Lanka, Peradeniya, Sri Lanka, J. Sound Vib., 57 (4), pp 515-522 (Apr 22, 1978) 5 figs, 1 table, 10 refs

Key Words: Shafts, Critical speeds, Resonant frequencies, Natural frequencies

Some basic properties of receptance functions are employed to determine the stationary values of the critical frequencies of a multi-span shaft in which the position of one of the bearings can be varied. Details are given of the determination of the maximum and minimum values of the first two critical frequencies. The theory is then extended to obtain the spacing of the intermediate supports for the first critical to be a maximum. The method is also employed to determine the maximum fundamental frequency of a beam or shaft having a freely articulating internal joint of variable position.

BEAMS, STRINGS, RODS, BARS

78-1438

The Modal Properties of Model and Full Scale Cooling Towers

P.E. Winney

Central Electricity Res. Laboratories, Leatherhead KT22 7SE, UK, J. Sound Vib., 57 (1), pp 131-138 (Mar 8, 1978) 14 figs, 3 tables, 15 refs

Key Words: Cooling towers, Towers, Wind-induced excitation, Resonance tests, Mode shapes

Resonance tests have been carried out on a model and full scale cooling tower. The object of the tests was to determine the resonant frequencies, mode shapes and associated damping ratios of the wind shield and legs. The tests have produced data which have been used to check the validity of a theoretical method of assessing dynamic response, and the correctness of currently accepted modeling criteria has been explicitly demonstrated.

78-1439

Free Vibration Analysis of Cooling Towers with Column Supports

R.L. Nelson and D.L. Thomas

Central Electricity Res. Labs., Leatherhead KT22 7SE, UK, J. Sound Vib., 57 (1), pp 149-153 (Mar 8, 1978) 1 fig, 9 refs

Key Words: Cooling towers, Towers, Free vibration, Finite element technique, Resonant frequencies

A cooling tower with column supports is a rotationally periodic structure. This property has been used to develop a finite element technique to analyze the free vibration of such structures while explicitly including the effects of column supports. The resonant frequencies and mode shapes of a model cooling tower have been measured.

78-1440

Moving Harmonic Load on an Elastically Supported Timoshenko Beam

S. Chonan

Z. Angew. Math. Mech., 58 (9), pp 9-15 (Jan 1978) 10 figs, 10 refs

Key Words: Beams, Elastic foundations, Moving loads, Timoshenko theory

An analysis is made of the problem of vibrations of a beam on elastic foundation, when the beam is of infinite length and is subjected to an alternating load which moves with constant velocity along the beam. The solution is presented within the framework of a beam theory which includes the effects of shear deformation and rotary inertia. Critical characteristic parameters of the system are defined. An example is provided where the displacement and the bending moment are calculated. From the results of theoretical analysis, it becomes evident that the frequency of the load has considerable effect upon the dynamic behavior of the system.

78-1441

Finite Space-Time Element Technique for the Calculation of Deflections of a Beam Caused by a Series of Moving Loads (Zur Berechnung von Durchsenkungen eines Balkens unter Folgen von Wandernden Lasten mit Finiten Raum-Zeit-Elementen)

H. Malsch

Lehrstuhl f. Mech. u. Festigkeitslehre, T.U. Braunschweig, Pockelsstrasse 4, D-3300 Braunschweig, West Germany, Ing. Arch., 47 (2), pp 105-115 (1978) 15 figs, 3 tables, 7 refs
(In German)

Key Words: Beams, Moving loads, Finite element technique

The discretization of space and time leads to an approximation for the deflections of a beam under sequences of moving loads. It is shown that simplifications of the mathematical equation for analytical approximations are possible only under certain restrictions.

78-1442

Finite Elements for Vibration Analysis of a Beam

D. Budcharoentong

Ph.D. Thesis, The Pennsylvania State Univ., 193 pp (1977)
UM 7808333

Key Words: Beams, Bernoulli-Euler method, Vibration response, Finite element technique

Two different approaches are suggested for the improvement of the accuracy of the finite element representation for dynamic analysis of a Bernoulli-Euler beam in the high frequency range. First, the concept of a generalized coordinate is used to generate a non-consistent, non-diagonal mass matrix. The non-consistent mass matrix is based on a quadratic displacement function. The generalized coordinates of the quadratic displacement function are evaluated after the unknown constants in the displacement function are chosen. The second approach is based on a mechanical impedance concept.

78-1443

Optimum Design of Structures with Regard to Their Vibrational Characteristic (4th Report. Type 1. Problems of Beams Subjected to Axial Forces)

H. Yamakawa, M. Amari, M. Kunihiro, and K. Kawashima

School of Science and Engrg., Waseda Univ., Shinjuku-ku, Tokyo, Japan, Bull. JSME, 21 (154), pp 637-643 (Apr 1978) 17 figs, 1 table, 3 refs

Key Words: Beams, Axial excitation, Optimization

Buckling problems of beams subjected to axial forces and columns with regard to their own weight are emphasized. A calculation of optimum shapes of vibrating beams subjected to axial forces which will have the maximum fundamental natural frequencies under specified total mass is presented in this report. Many numerical results are demonstrated and discussed in detail.

78-1444

The Large Amplitude Vibration of Tapered Clamped Beams

G. Prathap and T.K. Varadan

Dept. of Aeronautical Engrg., Indian Inst. of Tech., Madras 600036, India, J. Sound Vib., 58 (1), pp 87-94 (May 8, 1978) 5 figs, 5 tables, 12 refs

Key Words: Beams, Variable cross section, Free vibration

The large amplitude free vibrations of a beam with immovable clamped ends with actual nonlinear equilibrium equations (i.d., specification of loads in terms of the deformed configuration), exact nonlinear expression for curvature, and no assumption made on axial force have been determined by a simple numerically exact successive integration and iterative technique. By application of this technique, together with the definition of an eigenvalue-like quantity arising from certain definitions of the time function, results have been produced showing the dependence of the hardening effect of nonlinearity on amplitude of vibration, for selected values of several parameters such as taper ratio, slenderness ratio, and axial force.

78-1445

In-Plane Vibrations of Curved Bars

K. Suzuki, S. Takahashi, and H. Ishiyama

Faculty of Engrg., Yamagata Univ., Yonezawa, Japan, Bull. JSME, 21 (154), pp 618-627 (Apr 1978) 18 figs, 3 tables, 4 refs

Key Words: Curved beams, Bars, Natural frequencies, Mode shapes, Boundary condition effects

The in-plane free vibrations of curved bars with constant cross section, of which center lines are some plane curves are investigated by neglecting the rotatory inertia and the shear deformation. A rigorous method for solving the equations of motion is presented. As numerical examples, the frequencies and the mode shapes are shown in graphs for symmetric arc bars with clamped ends having the center lines in the form of sine, catenary, hyperbola, parabola, cycloid and for an asymmetric elliptic arc bar with both ends clamped.

78-1446

Application of Optimization Methods to Vibration Control of Stretched Strings

D.N. Dutt and B.S. Ramakrishna

Dept. of Electrical Communication Engrg., Indian Inst. of Science, Bangalore 560012, India, J. Sound Vib., 57 (4), pp 499-514 (Apr 22, 1978) 10 figs, 6 tables, 22 refs

Key Words: Strings, Optimization, Vibration control

In this paper, non-linear programming techniques are applied to the problem of controlling the vibration pattern of a stretched string. For this problem the relative merits of various methods of non-linear programming are compared. The more complicated problem of finding the positions and magnitudes of two control forces to obtain the desired energy pattern is then solved by using the slack unconstrained minimization technique with the Fletcher-Powell search.

78-1447

Analysis of a Randomly Excited Non-Linear Stretched String

G. Tagata

Nippon Gakki Co. Ltd., 10-1, Nakazawa-Cho, Hamamatsu, Japan, J. Sound Vib., 58 (1), pp 95-107 (May 8, 1978) 4 figs, 12 refs

Key Words: Strings, Random excitation

In a frequency region such that the non-linear terms arise from the fact that a string stretches in oscillation when a narrow band random external force is applied for a long period to the string, it has been observed in digital simulation results that there is a small amplitude for which the amplitude probability density characteristic shows an anomalous "notchy" behavior. In the Fokker-Planck equation obtained when the stretched string is described by this non-linear differential equation with narrow band random forcing, the ampltiude probability density characteristic is calculated by a polynomial approximation. The transition probability density function can be estimated by this method.

BEARINGS

78-1448

Constant-Velocity U-Joints

G.H. Sutherland

Advanced Design Methods Lab., Ohio State Univ., Columbus, OH, Mach. Des., 50 (9), pp 55-59 (Apr 20, 1978)

Key Words: Bearings

A new set of equations is presented to calculate bearing reaction forces for the four most common mounting designs. All necessary equations are included, and they can be handled easily on a programmable calculator.

BLADES

78-1449

Feedback Control of Saw Blade Temperature with Induction Heating

C.D. Mote, Jr. and S. Holoyen

Dept. of Mech. Engrg., Univ. of California, Berkeley, CA, J. Engr. Indus., Trans. ASME, 100 (2), pp 119-126 (May 1978) 18 figs, 3 tables, 10 refs

Key Words: Saws, Blades, Thermal excitation

Control of the axisymmetric temperature distribution in a circular saw has been shown to be an effective means of reducing blade vibrations. Theoretical and supporting experimental analyses of a basic induction heating coil design are presented here. An IR thermometer was designed to measure the blade temperature. Transient heating, transient cooling and steady state temperature experiments on circular saws were conducted both in the laboratory and in production. The true set point temperature was maintained to within 2 degree Celsius.

CYLINDERS

(See No. 1412)

DUCTS

78-1450

Acoustic Propagation in Nearly Annular Ducts

S. Sridhar and A.H. Nayfeh

West Virginia Univ., Morgantown, WV 46506, J. Sound Vib., 58 (1), pp 15-26 (May 8, 1978) 3 tables, 15 refs

Key Words: Ducts, Sound propagation

The propagation of acoustic waves in a duct of nearly annular cross-section is investigated. A method, based on a perturbation technique, is developed for calculating the wavenumbers of the propagating modes. Numerical results are presented for the case of an annular duct having an elliptical outer boundary and a circular inner boundary, and a cylindrical duct having an elliptical boundary.

78-1451

Sound Propagation Through a Subsonic Jet Due to a Source Near the Duct Exit

L. Ting

Courant Inst. of Mathematical Sciences, New York Univ., New York, NY 10012, J. Sound Vib., 57 (4), pp 523-534 (Apr 22, 1978) 2 figs, 1 table, 18 refs

Sponsored by NASA Langley Research Center

Key Words: Ducts, Sound propagation

Matched asymptotic solutions are constructed for the acoustic potentials of a periodic point source located in a two-dimensional subsonic jet near the exit of the duct with the ratio of the duct thickness to the acoustic wave length as the small parameter. The leading term of the far field solution has the same directionality effect as that for an infinite jet without the duct and that when the plane at the duct exit is considered to be a plane of symmetry. However, the intensity is different because of the wave propagation into the duct and is dependent on the location of the source.

GEARS

78-1452

Analysis of the Vibratory Excitation of Gear Systems: Basic Theory

W.D. Mark

Bolt Beranek and Newman, Inc., Cambridge, MA 02138, J. Acoust. Soc. Amer., 63 (5), pp 1409-1430 (May 1978) 8 figs, 19 refs

Key Words: Gears, Vibration excitation

Formulation of the equations of motion of a generic gear system in the frequency domain is shown to require the Fourier-series coefficients of the components of vibration excitation; these components are the static transmission errors of the individual pairs of meshing gears in the system. A general expression for the static transmission error is derived and decomposed into components attributable to elastic tooth deformations and to deviations of tooth faces from perfect involute surfaces with uniform lead and spacing. The component due to tooth-face deviations is further decomposed into appropriately defined mean and random components. The harmonic components of the static transmission error that occur at integral multiples of the tooth-meshing frequency are shown to be caused by tooth deformations and mean deviations of the tooth faces from perfect involute surfaces. Harmonic components that occur at the remaining multiples of gear-rotation frequencies are shown to be caused by the random components of the tooth-face deviations. Expressions for the Fourier-series coefficients of all components of the static transmission error are derived in terms of two-dimensional Fourier transforms of local tooth-pair stiffnesses and stiffness-weighted weighted deviations of tooth faces from perfect involute surfaces. Results are valid for arbitrary, specified tooth-face contact regions and include spur gears as the special case of helical gears with zero helix angle.

LINKAGES

78-1453

Studies on the Failure of Metal Mechanical Joints Subjected to Dynamic Loads

C.A. Ross, R.L. Sierakowski, and J.W. Hoover

Graduate Engrg. Center, Florida Univ., Eglin AFB, FL, Rept. No. AFOSR-TR-78-0078, 46 pp (Sept 20, 1977)

AD-A050 076/9GA

Key Words: Joints (junctions), Dynamic tests

A series of experimental dynamic tests were conducted on riveted joints and struts with central holes to establish quantitatively fracture mechanisms and to determine dynamic load factors based on measured strains. Results of these experimental tests on aluminum struts with a central circular indicate that dynamic stress concentrations associated with the hole are approximately equal to the static stress concentrations for the same specimen. Riveted joints subjected to dynamic loadings exhibit the same general fracture/failure modes associated with similarly static loaded riveted joints. Dynamic response of riveted joints and subsequent fracture is very dependent on the joint stiffness and loading history.

PIPES AND TUBES

(Also see Nos. 1392, 1460)

78-1454

Subsurface Transportation of Long Marine Pipelines

W. Kan

Ph.D. Thesis, The Univ. of Texas at Austin, 175 pp (1977)

UM 7807328

Key Words: Underwater pipelines, Pipelines, Pipeline transportation, Mathematical models, Frequency response method

The major contribution of this work is the development of techniques necessary for the study of static, dynamic and random stress characteristics of a long marine pipeline system being transported under the sea surface to a connection site. This method of offshore pipeline construction offers substantial cost savings where deep water oil and gas wells are concerned. Analytical models and numerical algorithms are developed for predicting the configuration and stress distribution along the line during the subsurface transportation phase. The successive linearization technique and the transfer matrix method in structural analysis are utilized to obtain solutions to the nonlinear two point boundary value pipeline system equations. Discrete bouyancy forces along the line will also be necessary in practice to reduce the barge thrust requirements while maintaining safe stress levels. The effects of buoy forces are included in this model.

78-1455

Seismic Response Analysis of Structural System Subjected to Multiple Support Excitation

R.W. Wu, F.A. Hussain, and L.K. Liu
Nuclear Energy Systems Div., General Electric Co., San Jose, CA 95125, Nucl. Engr. Des., 47 (2), pp 273-282 (May 2, 1978) 3 figs, 5 tables, 9 refs

Key Words: Piping systems, Nuclear power plants, Seismic response

In the seismic analysis of a multiply supported structural system subjected to nonuniform excitations at each support point, the single response spectrum, the time history, and the multiple response spectrum are the three commonly employed methods. In the present paper the three methods are developed, evaluated, and the limitations and advantages of each method assessed. A numerical example has been carried out for a typical piping system. Considerably smaller responses have been predicted by the time history method than that by the single response spectrum method. This is mainly due to the fact that the phase and amplitude relations between the support excitations are faithfully retained in the time history method. The multiple response spectrum prediction has been observed to compare favorably with the time history method prediction.

78-1456

Crossflow-Induced Vibrations of Heat Exchanger Tube Banks

S.S. Chen
Components Technology Div., Argonne National Lab., Argonne, IL 60439, Nucl. Engr. Des., 47 (1), pp 67-86 (May 1978) 9 figs, 4 tables, 24 refs

Key Words: Tubes, Heat exchangers, Fluid-induced excitation, Mathematical models

This paper presents a mathematical model for crossflow-induced vibration of tube banks. Motion-dependent fluid forces and various types of flow noises are incorporated in the model. An analytical solution for the fluid inertia force, hydrodynamic damping force, and fluid elastic force is given for tube banks arranged in an arbitrary pattern. Based on the model, a better understanding of the vibrations of heat exchanger tube banks subjected to various flow excitations was developed.

78-1457

Parametric Vibrations of Nonlinear Tubes due to Biharmonic Excitation (Vibrations Parametriques D'Une Enveloppe Cylindrique D'Un Materiau Elastique Non Lineaire A Excitation Biharmonique)

T. Batsinov
VMEI, Varna, R.P. de Bulgarie, J. de Mecanique Appl., 22 (6), pp 897-906 (1977) 3 figs, 7 refs (In French)

Key Words: Tubes, Parametric vibration

This paper reports on a study of parametric vibrations of a slender tube with nonlinear material characteristics subject to biharmonic excitation. Equations are formulated and dynamic stability is studied from the point of view of small parameters. Dynamic stability is determined for both transverse and axial motions.

PLATES AND SHELLS

(Also see No. 1391)

78-1458

Effect of Shear Deformation on Vibration of Antisymmetric Angle-Ply Laminated Rectangular Plates

C.W. Bert and T.L.C. Chen
School of Aerospace, Mech. and Nuclear Engrg., The Univ. of Oklahoma, Norman, OK 73069, Intl. J. Solids Struc., 14 (6), pp 465-473 (1978) 5 figs, 2 tables, 20 refs

Key Words: Rectangular plates, Composite materials, Numerical analysis, Finite element technique

The title problem is solved in closed form for the case of all edges simply supported. A displacement formulation of the heterogeneous shear-deformable plate theory originated by Yang, Norris and Stavsky is used. Material properties typical of a highly directional composite material (high-modulus graphite/epoxy) are used and numerical results are presented showing the parametric effects of aspect ratio, length/thickness ratio, number of layers, and lamination

angle. The effects of deleting rotatory inertia and in-plane inertia, singly and in combination, were also investigated. The information presented should be useful to composite-structure designers, to researchers seeking to obtain better correlation between theory and experiment, and to numerical analysts in checking out finite-element programs.

78-1459

Vibrational Analysis of the Superphenix Internal Shells

M. Livolant and F. Jeanpierre
Commissariat a l'Energie Atomique, CEN/Saclay-DEMT, B.P. No. 2, F-91190 Gif sur Yvette, France, Nucl. Engr. Des., 47 (2), pp 289-296 (1978) 8 figs, 2 tables, 1 ref
(In French)

Key Words: Cylindrical shells, Nuclear reactor components, Fluid-induced excitation, Fatigue life

The geometry of the internal shells of Superphenix is somewhat complicated; they are mainly axisymmetric with some special parts, like pumps and heat exchanger crossing, non-axisymmetric. The flow leaving the reactor core or the heat exchanger strikes some of these shells and induces vibrations. Owing to the expected long life of the plant, without the possibility of intervention on the shells, it is necessary to verify that the vibrational level is sufficiently low and that there is no risk of fatigue. A first estimate of the vibrational level has been calculated. This paper explains the formalism used and describes the main steps of the calculation: estimation of the fluctuating pressures; calculation of the structural resonances, taking into account the sodium effects; and estimation of the resulting vibrational amplitude. A short review of the experimental work planned to verify and validate the calculation results is presented.

78-1460

Vibration and Dynamic Instability of a Cylindrical Shell Conveying a Compressible Fluid

K. Mizoguchi and S. Komori
Faculty of Science and Tech., Kinki Univ., Higashi-Osaka, Japan, Bull. JSME, 21 (154), pp 628-636 (Apr 1978) 11 figs, 7 refs

Key Words: Cylindrical shells, Pipes (tubes), Fluid-filled containers, Fluid-induced excitation

This paper deals with the vibration and the stability of a cylindrical shell conveying a compressible fluid taking into account an effect of the boundary layer of the fluid. Mizoguchi's shell theory is used and the compressible fluid is treated as an ideal gas.

78-1461

Modeling of the Cat Eardrum as a Thin Shell Using the Finite-Element Method

W.R.J. Funnell and C.A. Laszlo
BioMedical Engrg. Unit, Dept. of Otolaryngology, McGill Univ., Montreal, Quebec, Canada, J. Acoust. Soc. Amer., 63 (5), pp 1461-1467 (May 1978) 4 figs, 34 refs

Key Words: Shells, Mathematical models, Finite element technique, Organs (biological)

A finite-element model of the cat eardrum is presented which includes the effects of the three-dimensional curved conical shape of the drum. The model is valid at low frequencies and within the range of linear vibration amplitudes. The material properties used are based on a review of the literature. The model exhibits a vibration pattern and amplitude very similar to those observed experimentally using laser holography. A number of parameters are varied in order to study their relative importance in the model.

78-1462

Natural Frequencies of Prolate Spheroidal Shells of Constant Thickness

C.B. Burroughs and E.B. Magrab
Bolt Beranek and Newman, Inc., Cambridge, MA 02138, J. Sound Vib., 57 (4), pp 571-581 (Apr 22, 1978) 2 figs, 13 refs

Key Words: Spherical shells, Transverse shear deformation effects, Rotatory inertia effects, Natural frequencies

The general displacement-equilibrium equations, which include the effects of transverse shear and rotary inertia, have been derived for a prolate spheroidal shell of constant thickness subject to an harmonically time-varying, arbitrary spatially distributed force normal to the shell surface. The approximate solutions for the two non-torsional displacements of the shell middle surface and the non-torsional rotation of the shell cross-section are obtained by using Galerkin's variational method. Numerical results are presented for the seven lowest axisymmetric natural frequencies of the shell.

78-1463

Free Oscillations of Submerged Spherical Shells

Y.K. Lou and T.C. Su
Dept. of Civil Engrg., Texas A&M Univ., College Station, TX, J. Acoust. Soc. Amer., 63 (5), pp 1402-1408 (May 1978) 5 figs, 1 table, 9 refs

Key Words: Spherical shells, Submerged structures, Natural frequencies

Free vibrations of a spherical shell submerged in a fluid medium are investigated. It is found that no undamped natural frequency of the submerged shell can exist even if the surrounding fluid is assumed inviscid. In this case the damping is solely due to the compressibility of the fluid. However, for the intermediate modes, the damping components of the complex frequencies are extremely small; thus, an almost steady-state, undamped free oscillation is possible for these modes and a pronounced resonance may be observed for the forced vibrations. When the shell is submerged in an ideal fluid, it is shown that there exist two real natural frequencies for each mode. These frequencies are lower than the corresponding in vacuo natural frequencies. The effect of fluid viscosity on the complex natural frequencies has also been examined. It is found that for small viscosities, the viscosity has essentially no effect on the real component of the natural frequencies.

78-1464

Unsteady Aerodynamic Forces on Harmonically Oscillating Pointed Circular Conical Shells with Small Aperture Angle (Instationaere Luftkraefte an Harmonisch schwingenden Spitzen Kreiskegelschalen mit kleinem Oeffnungswinkel)

H. Foersching and K.-L. Chao

Inst. f. Aeroelastik, Deutsch Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Goettingen, West Germany, Contrib. to Steady and Unsteady Aerodyn., pp 33-48 (Aug 10, 1977) Avail: see N78-17004 08-02

(In German)

N78-17007

Key Words: Conical shells, Aerodynamic loads, Aircraft

The analytical relations for the calculations were derived from the slender body theory. Numerical calculations were carried out for some typical examples and results compared with those of the piston theory.

78-1465

Vibration -- Analysis of Circular-Arc Aerofoil Shaped Plates

H.B. Khurasia and S. Rawtani

M.A. College of Tech., Bhopal-462 007, India, Intl. J. Mech. Sci., 20 (5), pp 283-393 (1978) 6 figs, 8 refs

Key Words: Plates, Natural frequencies, Mode shapes, Finite element technique

Circular-arc aerofoil flat plates are analyzed for their vibrational characteristics using the finite element approach. The effect of variation in the lune angles of the aerofoil plates, on natural frequencies and mode shapes is investigated. Two types of plate bending finite elements are used in the investigation; one is the conventional nine degree of freedom triangular element and the other is a modified triangular element with one edge curved. The later element has been specially developed and used near the curved boundaries of the plate, whereas the former straight edged element is used in the interior. The results of the finite element analysis are verified through experimental investigations.

78-1466

Acoustic Transmission Through Orthotropic Multilayered Plates. Part 1: Plate Vibration Modes

J.L. Guyader and C. Lesueur

Vibration-Acoustic Lab., National Inst. of Applied Sciences, 69621 Villeurbanne Cedex, France, J. Sound Vib., 58 (1), pp 51-68 (1978)

Key Words: Plates, Layered materials, Orthotropism, Sound transmission

Equations of motion and natural boundary conditions for multilayered plates are established by using a variational displacement formulation. The continuity of displacements and shear stresses are verified at the interfaces. An important point is that equations of motion and natural boundary conditions remain unchanged in form whatever the number of layers. The equations are solved for a simply supported plate. Analytic solutions are obtained that are used, in the second part of this paper (Part II), to calculate the transmission loss of multilayered plates. Numerical results are then presented.

78-1467

Large Amplitude Flexural Vibration of Stiffened Plates

G. Prathap and T.K. Varadan

Dept. of Aeronautics, Indian Inst. of Tech., Madras-600036, India, J. Sound Vib., 57 (4), pp 583-593 (Apr 22, 1978) 7 figs, 10 refs

Key Words: Stiffened plates, Plates, Flexural vibration

The large amplitude free flexural vibration of thin, elastic orthotropic stiffened plates is studied. The boundary conditions considered are either simply supported on all edges or clamped on all edges and the in-plane edge conditions are either immovable or movable. The governing dynamic equations are derived in terms of non-dimensional parameters describing the stiffening achieved, and the solutions are obtained on the basis of an assumed one-term vibration mode shape for various stiffener combinations. In all cases, the nonlinearity is found to be of the hardening type. Some interesting conclusions are drawn as to the effect of the stiffening parameters on the nonlinear behavior. A simple method of predicting the postbuckling and static large deflection behavior from the results obtained in this analysis is included.

78-1468

Attenuated Forced Oscillations of Isotropic and Orthotropic Plates

S. Katsaitis

Fortschritt-Berichte d. VDI-Zeitschriften, Ser. 11, No. 28, 86 pp (1978) 17 figs, Avail: VDI-Verlag G.m.b.H., Postfach 1139, 4000 Düsseldorf, Germany, Taken from: VDI-Z, 120 (6), pp 259-260 (1978) 1 fig
(In German)

Key Words: Plates, Internal damping

An approximate solution for the prediction of the internal damping in plates at resonance is presented. The solution, based on Galerkin method, may be used for plates with various boundary conditions and surfaces - rectangular, triangular, trapezoidal, as well as polygonal and circular shapes.

STRUCTURAL

(Also see No. 1411)

78-1469

Nonlinear Vibrations of Structural Elements Subject to Multi-Frequency Excitations

Z. Mojaddidy

Ph.D. Thesis, Virginia Polytechnic Inst. and State Univ., 113 pp (1977)
UM 7807220

Key Words: Structural members, Beams, Nonlinear response, Coupled response

Relatively large-amplitude responses of structural elements subject to multi-frequency aperiodic excitations are studied. The governing equation of motion, which accounts for a weak cubic nonlinearity that is due to the stretching of the mid-plane, and linear viscous modal damping, is reduced to a set of second-order coupled nonlinear ordinary differential equations with constant coefficients. These equations which are of Duffing type are then solved by the perturbation method of Multiple Scales, and various resonances are studied with and without modal coupling (internal resonances). Of special interest, are simultaneous and combination external resonances. The study of these resonances emphasize the importance of accounting for all the forces present in a nonlinear vibrating system.

SYSTEMS

ABSORBER

78-1470

Selection of Anti-Vibration Mounts

J.S. Smith

Moniton Technic, Ltd., Noise Control Vib. Isolation, 9 (4), pp 123-124 (Apr 1978) 3 figs

Key Words: Equipment mounts, Vibration control

Factors which should be considered in the selection of anti-vibration mounts for machinery are discussed. They are the lowest running speed of the unit, energy absorbed by the unit, total weight and its distribution for the unit, grade (or floor) on which the unit is to be positioned, type of flooring (e.g., concrete, wooden planks, beams), and type of area (e.g., residential, industrial, etc.).

78-1471

Effects of Structural and Forming Parameters on the Efficiency of Energy Transfer in Impact Forming Machines

S. Vajpayee and M.M. Sadek

Dept. of Mech. Engrg., Univ. of Birmingham, UK, J. Engr. Indus., Trans. ASME, 100 (2), pp 113-118 (May 1978) 9 figs, 8 refs

Key Words: Forging machinery, Shock absorbers

This work deals with the efficiency of energy transfer in impact forming machines due to the interaction of the process with machine structure as represented by a two degree-of-freedom system. The forming process is simulated by a rectangular force pulse as a function of time. The effects of various parameters of the structure and also of the pulse on the energy transfer have been explored.

78-1472

Stiffness and Damping of Elastomeric O-Ring Bearing Mounts

A.J. Smalley

Res. and Dev. Div., Mechanical Technology, Inc., Latham, NY, Rept. No. NASA-CR-135328; MTI-78TR17, 75 pp (Nov 1977)

N78-18460

Key Words: Bearings, Mountings, Rings, Elastomers, Dynamic tests, Dynamic stiffness, Damping

A test rig to measure the dynamic stiffness and damping of elastomer O rings was described. Test results for stiffness and loss coefficient in the frequency range from 50 Hz to 1000 Hz are presented. Results are given for three different materials, for five temperatures, for three amplitudes, for five values of squeeze for three values of stretch for three values of cross-section diameter and for three values of groove width. All test data points were plotted. In addition, trend summary plots were presented which compare the effect of material, temperature, amplitude, squeeze, stretch, cross-section diameter, and groove width. O ring deflections under a static load for different material were presented; and effective static stiffness values were compared with dynamic values.

78-1473

Design Considerations in Energy Absorption by Structural Collapse

C.L. Magee and P.H. Thornton

Ford Motor Co., Dearborn, MI, SAE Paper No 780434, 20 pp, 13 figs, 7 tables, 15 refs

Key Words: Energy absorption, Crashworthiness

A general treatment of the absorption of mechanical energy by the axial collapse of a variety of structural shapes, including tubes, honeycombs and foams is developed which encompasses both the geometry of the structure and also the material properties. The use of the method in the design of load bearing structures in which energy absorption is an additional design function is illustrated. High strength-to-weight ratio materials offer a significant weight saving for energy absorbing components, although such materials may have a reduced tensile ductility. The implications to situations in vehicle crashworthiness are discussed.

NOISE REDUCTION

(Also see Nos. 1478, 1508, 1511)

78-1474

Reducing Noise in Hydraulic Systems

Noise Control Vib. Isolation, 9 (4), p 131 (Apr 1978) 2 figs

Key Words: Noise reduction, Hydraulic equipment, Pumps, Valves

Noise pollution is a factor to be considered when selecting machinery and industrial components. The noise of oil-hydraulic applications is mainly generated by three different sources: pumps, hydraulic transients, and valves. Noise from transients and hydraulic valves and some useful precautions to minimize the noise are described.

78-1475

Designing Simple Low-Pass Filter Mufflers for Small Two-Cycle Engines

W. Soedel

Ray W. Herrick Labs., School of Mech. Engrg., Purdue Univ., West Lafayette, IN 47907, Noise Control Engr., 10 (2), pp 60-66 (Mar/Apr 1978) 5 figs, 1 table, 13 refs

Key Words: Engine mufflers, Design techniques

The author details an approach to the one-cylinder engine that filters out most of the Helmholtz resonator noise band without creating too much back pressure that would impede engine performance. The step-by-step formulas allow the designer to select muffler parameters, thus eliminating much of the necessary trial-and-error work.

78-1476

Noise Reduction in Queensland Sugar Mills

D. Macey

141 N. Cray Rd., Sidcup, Kent, UK, Noise Control Engr., 10 (2), pp 67-73 (Mar/Apr 1978) 11 figs, 1 ref

Key Words: Industrial noise, Noise reduction

Noise levels at the majority of operator locations in Queensland sugar mills are 5 to 10 dB(A) higher than the target level of 85 dB(A). Noise sources include a broad range of machinery and procedures. The progress in reducing the noise of locomotives, shredders, and the steam system is described.

78-1477

Laboratory Study of Jet-Noise Suppressors

R.E.A. Arndt, H.V. Fuchs, and U. Michel
St. Anthony Falls Hydraulic Lab., Univ. of Minnesota, Minneapolis, MN 55414, J. Acoust. Soc. Amer., 63 (4), pp 1060-1068 (Apr 1978) 18 figs, 1 table, 8 refs

Key Words: Jet noise, Noise reduction

Experiments on four different types of subsonic jet-noise suppressors are reported. The suppressors were compared to a clean circular jet on an equal-thrust per unit-exit-area basis. On this basis the noise production of the different jets varied only slightly, in contrast to some results reported previously.

AIRCRAFT

(Also see Nos. 1388, 1406, 1464, 1484)

78-1478

A Method for Assessing Turbine Engine Run-Up Noise Impact on Airport Neighbors

R.W. Tagg

Propulsion Performance/Stability Div., Wright-Patterson AFB, OH, SAE Paper No. 780522, 5 figs, 2 tables, 6 refs

Key Words: Aircraft noise, Turbine engines, Engine noise, Noise reduction

A methodology for assessing ground run-up noise exposure/impact resulting from turbine engine performance testing on outdoor facilities was developed. The overall methodology consists of three calculation procedures using dBA levels (measured or estimated) to predict the Day-Night Level (LDN) at any location across existing terrain. The methodology provides the analysis capability required to study noise suppressor requirements in order to minimize costs, locate run-up and test-cell pads, and study the impact of run-up operations changes. It also provides a potential capability for assessing noise exposure from takeoff power check runups, or other (non-turbine) static noise sources.

78-1479

Significance of Structural Nonlinearities from the Structural Dynamics and Aeroelasticity Point of View (Die Bedeutung Struktureller Nichtlinearitaeten aus der Sicht der Struktur-dynamik und Aeroelastik)

E. Breitbach

Inst. f. Aeroelastik, Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Goettingen, West Germany, Contrib. to Steady and Unsteady Aerodyn., pp 7-19 (Aug 10, 1977) Avail: see N78-17004 08-02
(In German)
N78-17005

Key Words: Aircraft vibration, Flutter

The effects of structure-dependent nonlinearities on the dynamic behavior of aircraft structures were investigated, and their significance for flutter stability analysis and for solution of general dynamic response problems considered. Some measurement and analytical computation problems resulting from structural nonlinearities, and methods for resolving them, are discussed. Physical relations are explained using an example of rudder mechanism nonlinearities in manually controlled aircraft.

78-1480

Aircraft Structural Reliability Prediction Based on Dynamic Loads & Ultimate Strength Test Data

H.B. Chenoweth

Rockwell International, Los Angeles, CA, Combined Environments Technology Interrelations: Proc. of the 24th Annual Tech. Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 352-355 (Apr 18-20, 1978) 8 refs

Key Words: Aircraft, Damage prediction, Reliability

The economic constraints of today's aerospace vehicle design and development process have dictated the limiting of or the complete cessation of static tests of major aircraft components. This paper will attempt to derive a measure of the structural reliability which can be expected to result from this "no test" policy. It is shown that a "no static test" policy on major aircraft structural components yields extremely high probability of failure or unreliability. The question of this unreliability is presented to management and the profession as one of the major economic and technical problems of technology today.

78-1481

Dynamic Wind-Tunnel Tests of an Aeromechanical Gust-Alleviation System Using Several Different Combinations of Control Surfaces

E.C. Stewart and R.V. Doggett, Jr.

Langley Res. Center, NASA, Langley Station, VA, Rept. No. NASA-TM-78638; L-11918, 37 pp (Mar 1978)
N78-19059

Key Words: Aircraft, Wind tunnel tests, Wind-induced excitation

Some experimental results are presented from wind tunnel studies of a dynamic model equipped with an aeromechanical gust alleviation system for reducing the normal acceleration response of light airplanes. The gust alleviation system consists of two auxiliary aerodynamic surfaces that deflect the wing flaps through mechanical linkages when a gust is encountered to maintain nearly constant airplane lift. The gust alleviation system was implemented on a 1/6-scale, rod mounted, free flying model that is geometrically and dynamically representative of small, four place, high wing, single engine, light airplanes.

78-1482

Effect of Chordwise Forces and Deformations and Deformation Due to Steady Lift on Wing Flutter

W.N. Boyd

Ph.D. Thesis, Stanford Univ., 256 pp (1978)

UM 7808767

Key Words: Aircraft wings, Cantilever beams, Flutter

This investigation explores the effects of chordwise forces and deformations and steady-state deformation due to lift on the static and dynamic aeroelastic stability of a uniform cantilever wing. Results of this analysis are believed to have practical applications for high-performance sailplanes and certain RPV's. The airfoil cross section is assumed to be symmetric and camber bending is neglected. Motions in vertical bending, fore-and-aft bending, and torsion are considered. The stability analysis is carried out in terms of the dynamically uncoupled natural modes of vibration of the uniform cantilever.

BRIDGES

78-1483

An Analysis of Binary Flutter of Bridge Deck Sections

Y. Nakamura

Research Inst. for Appl. Mechanics, Kyushu Univ., Fukuoka, Japan, J. Sound Vib., 57 (4), pp 471-482 (Apr 22, 1978) 6 figs, 12 refs

Key Words: Suspension bridges, Flutter

This paper is concerned with an analytical and experimental study of binary flutter of bridge deck sections. A set of analytical formulas giving the frequency and rate of growth of oscillation, the position of the equivalent center of rotation and the phase difference between bending and torsion near the critical flutter point is presented. The formulas provide an analytical basis for the previously proposed method of classification of binary flutter of bluff structures. The results of wind tunnel experiments on models with simple geometrical shapes confirm that the present formulas are applicable to a variety of structures ranging from a flat plate to much more bluff bridge deck sections.

BUILDING

(Also see No. 1405)

78-1484

Concorde Noise-Induced Building Vibrations John F. Kennedy International Airport

W.H. Mayes, R. DeLoach, D.G. Stephesn, J.M. Cawthorn, H.K. Holmes, R.B. Lewis, B.G. Holliday, and D.W. Ward

Langley Res. Center, NASA, Langley Station, VA, Rept. No. NASA-TM-78660, Rept-1, 38 pp (Jan 1978)

N78-18873

Key Words: Aircraft noise, Buildings, Acoustic excitation

The outdoor and indoor noise levels resulting from aircraft flyovers and certain nonaircraft events were recorded at six home sites along with the associated vibration levels in the walls, windows, and floors of these test homes. Limited subjective tests conducted to examine the human detection and annoyance thresholds for building vibration and rattle caused by aircraft noise showed that both vibration and rattle were detected subjectively in several houses for some operations of both the Concorde and subsonic aircraft. Preliminary results indicate that the relationship between window vibration and aircraft noise is: linear, with vibration levels being accurately predicted from OASPL levels measured near the window; consistent from flyover to flyover for a given aircraft type under approach conditions; no different for Concorde than for other conventional jet transports (in the case of window vibrations induced under approach power conditions); and relatively high levels of window vibration measured during Concorde operations are due more to higher OASPL levels than to unique Concorde source characteristics.

78-1485

Tornado Structure Interaction: A Numerical Simulation

T. Wilson

Lawrence Livermore Lab., California Univ., Livermore, CA., Rept. No. UCRL-52207, 90 pp (May 20, 1977)

N78-19338

Key Words: Buildings, Wind-induced excitation, Computer programs

The American National Standards Institute (ANSI) has developed guidelines for building code requirements for the minimum wind loads a building must be designed to withstand. The conservation or nonconservation on the ANSI approach was evaluated by simulating tornado structure interaction numerically with a two-dimensional fluid dynamics computer code and a vortex model. Only external pressures were considered. The computer calculations yield the following percentages of the ANSI design pressures: rigid frame, 50 to 90 percent; individual wall panels, 75 to 200 percent; and wall corners, 50 to 75 percent.

78-1486

Measurement of Floor Mobility at Low Frequencies in Some Buildings with Long Floor Spans

F.J. Fahy and M.E. Westcott

Inst. of Sound and Vibration Res., Univ. of Southampton, Southampton S09 5NH, UK, J. Sound Vib., 57 (1), pp 101-129 (Mar 8, 1978) 38 figs, 23 refs

Key Words: Buildings, Floors, Vibration measurement

Point mobility curves for vertical excitation of the long span floors of a number of modern buildings have been derived by Fourier analysis of the acceleration response to transient forces applied by a hydraulic vibrator system. Collation of the damping ratios and peak mobilities associated with resonances in the frequency range 4 - 35 Hz clearly indicates the influence of non-structural components and occupants on the ranges of these quantities and strongly suggests that tests on unfinished, unoccupied buildings, and on isolated building components are of relatively little practical value.

FOUNDATIONS AND EARTH

78-1487

Ground Vibration from Cut-and-Cover Tunnel Construction

T.G. Gutowski

Bolt Beranek and Newman, Inc., Cambridge, MA, S/V, Sound Vib., 12 (4), pp 16-22 (Apr 1978) 10 figs, 2 tables, 12 refs

Key Words: Ground vibration, Pile driving, Construction industry, Tunnels

Ground vibration from construction activities can be annoying to neighbors. Common complaints are that vibrations are perceptible and that vibrations may cause building damage. This article reviews the results of a recent study to assess ground vibraton from alternative methods for cut-and-cover tunnel construction. The principal vibration sources considered here are pile driving, pile augering and slurry wall construction. The results of measurements for each of these methods are presented and compared with criteria for annoyance and building damage.

HELICOPTERS

(Also see Nos. 1418, 1429)

78-1488

DFVLR Rotorcraft Research

B. Gmelin, H.J. Langer, and P. Hamel

Inst. f. Flugmechanik, Deutsche Forschungs- und Versuchsanstalt f. Luft- und Raumfahrt, Brunswick, West Germany, In: AGARD Rotorcraft Design, 17 pp (Jan 1978)

N78-19146

Key Words: Reviews, Helicopters, Wind tunnels, Active flutter control, System identification technique

Selected activities in the field of rotorcraft research and development are presented and discussed: helicopter wind tunnel test stands, active vibration control, crew escape systems, and helicopter system identification.

HUMAN

78-1489

Elastohydrodynamic Lubrication in Human Joints

G.R. Higginson

Dept. of Engrg. Science, Univ. of Durham, Instn. Mech. Engr. Proc., 191 (34), pp 217-223 (1977) 9 figs, 13 refs

Key Words: Elastohydrodynamic properties, Organs (biological)

Recent developments in the analysis of elastohydrodynamic lubrication (EHL) of solids covered by soft layers, are applied to the big load-bearing human joints. It is concluded that the chances of generating a full film by conventional rolling/sliding EHL are small; but for loads of short duration the squeeze film mechanism looks very promising.

78-1490

A Dynamic Nonlinear Large Displacement Finite Element Model of a Human Leg

T.K. Hight

Ph.D. Thesis, Stanford Univ., 234 pp (1978)

UM 7808796

Key Words: Organs (biological), Mathematical models, Dynamic response, Finite element technique

A coordinated research effort has been undertaken to investigate the mechanisms of skiing injury. This thesis deals with a portion of that research, namely the computer modeling of the motion, forces and stresses of a human leg which is subjected to an experimentally measured forcing function. The investigation of skiing injuries represents a particular, but not an exclusive, application of this model.

78-1491

The Effect of the Position of the Axis of Rotation on the Discomfort Caused by Whole-Body Roll and Pitch Vibrations of Seated Persons

K.C. Parsons and M.J. Griffin

Inst. of Sound and Vib. Res., Univ. of Southampton, Southampton, S09 5NH, UK, J. Sound Vib., 58 (1), pp 127-141 (May 28, 1978) 5 figs, 3 tables, 7 refs

Key Words: Vibration excitation, Human response, Experimental data

Methods of predicting the discomfort caused by rotational vibration of subjects seated away from the axis of rotation from a knowledge of the discomfort caused by single-axis vibration were investigated. The method of category production was used, in which ten seated subjects adjusted the level of sinusoidal vibration until it could be described as "uncomfortable" on a given semantic scale. Judgments were made for four frequencies (2, 4, 8, and 16 Hz) for vibrations in each of five single-axis motions (roll, pitch, fore-and-aft, lateral, vertical) and for roll and pitch vibrations with subjects sitting various distances and directions away from the axis of rotation.

ISOLATION

(Also see No. 1404)

78-1492

Development of a Suspension Seat for Earthmoving Vehicles

L.J. Koutsky

Sear Mfg. Co., SAE Paper No. 780474, 16 pp, 15 figs

Key Words: Suspension systems (vehicles), Earth handling equipment

A suspension seat has been developed for earthmoving and other off-highway vehicles, following specific guidelines established by the manufacturers of such vehicles. A wide range of adjustments is provided to properly position the operator relative to the various vehicle controls. Several new ideas are employed, such as a fore-aft slide with self-cleaning rollers, a mechanical suspension spring system which provides air spring characteristics, and a seat/suspension package which will meet the SAE recommended practice for seat belt attachment strength without the need for additional tether belts.

78-1493

The Development of a Scraper Suspension System

P.B. Cadou and F.J. Bowser

Terex Div., General Motors, Hudson, OH, SAE Paper No. 780462, 12 pp, 11 figs

Key Words: Suspension systems (vehicles)

An optimum scraper suspension system was developed as a result of determining the performance and related cost characteristics of several alternative systems. The optimized system consists of a pivoted axle assembly controlled by hydro-pneumatic springs, and a hydraulic control system with self-leveling and manual on-off features.

78-1494

Ride Quality of Autorack Cars

L.P. Greenfield, L.A. McLean, and E.J. Wolf

Trailer Train Co., Chicago, IL, J. Engr. Indus., Trans. ASME, 100 (2), pp 171-180 (May 1978) 22 figs, 4 tables

Key Words: Ride dynamics, Freight cars, Suspension systems (vehicles), Hydraulic dampers

Results of tests are described whose object was to determine the effect that various levels of spring stiffness, friction damping, and the application of supplementary hydraulic damping devices have on the ride quality of an autorack car. Ride quality, for the purpose of this test report, is defined as the level of vertical acceleration (both RMS and magnitude) measured at the longitudinal car center line over the body centerplate on the A-deck.

78-1495

Design of Vibration Isolation Systems for Forging Hammers

E.I. Rivin

Ford Motor Co., Dearborn, MI, S/V, Sound Vib., 12 (4), pp 12-15 (Apr 1978) 5 figs, 7 refs

Key Words: Vibration isolators, Forging machinery, Hammers

Analytical relationships and empirical parameter values are presented that permit ready estimation of the effectiveness of isolation systems for impact machines. This information is then used to show how cost-effective installations may be designed.

78-1496

Improved Method for Minimizing Vibrational Motion Transmitted by Pumping Lines

W.P. Kirk and M. Twerdochlib

Physics Dept., Texas A&M Univ., College Station, TX 77843, Rev. Scientific Instr., 49 (6), pp 765-769 (June 1978) 3 figs

Key Words: Vibration isolators, Pumps

A description is given for a technique that is very effective in reducing vibrations transmitted along large-diameter vacuum and gas pumping lines. This technique uses a supported double-gimbal metal bellows design. When compared with other techniques such as the crossed T metal bellows design, a factor of seven improvement was measured. An analysis is included which compares the various techniques, and shows that, in principle, improvement factors as high as eighty or more can be realized with the double-gimbal design.

MECHANICAL

(Also see No. 1380)

78-1497

New Method Predicts Startup Torque. Part 1: Analytical Model

G. Mruk, J. Halloran, and R. Kolodziej

Joy Mfg. Co., Buffalo, NY, Hydrocarbon Processing, 57 (4), pp 181-186 (Apr 1978) 10 figs, 10 refs

Key Words: Motors, Torsional response, Mathematical models

Damaging startup torque, developed by synchronous motors, can be predicted by computer modeling of the motor coupled to a mass-elastic system. An approach is described which uses electromagnetic torque developed by the synchronous motor; and, therefore system acceleration effects upon resonant amplification factors are considered directly. This model, readily solved on conventional analog or digital computers, considers the air gap torque produced by asynchronous operation of salient-pole motors coupled with a mass-elastic system that takes into account non-linear spring rates and damping factors.

METAL WORKING AND FORMING

(Also see No. 1405)

78-1498

Stiffness of Machine Tool Spindles

H. Pittroff and U.A. Rimrott

SKF Kugellagerfabriken G.m.b.H., Schweinfurt, Germany, ASME Paper No. 77-WA/Prod-42

Key Words: Machine tools, Stiffness

In this paper, the parameters affecting spindle stiffness are reviewed and their influence on the accuracy of the workpiece is illustrated. Equations are derived which can be employed to determine the static and dynamic stiffness of the spindle as a function of rolling bearing deflections and spacing, and the asembly and mounting conditions.

78-1499

Application of the Regeneration Spectrum to the Design of Machine Tool Chatter Control Systems

K. Srinivasan and C.L. Nachtigal

Shell Development Co., Houston, TX, ASME Paper No. 77-WA/Aut-8

Key Words: Machine tools, Chatter, Vibration control, Control equipment

The development and design of existing machine tool chatter control systems has been largely based on a conservative measure of stability via the Merritt Chart. Some additional heuristic rules of thumb were adopted for the case of a force measuring chatter control system. This paper introduces a new concept in the analysis and design of chatter control systems, the regeneration spectrum.

78-1500

A Comparison of Methods for Measuring the Frequency Response of Mechanical Structures with

Particular Reference to Machine Tools

H.R. Taylor

Dept. of Electrical Engrg. and Electronics, Inst. of Science and Tech., Univ. of Manchester, Instn. Mech. Engr. Proc., 191 (16), pp 257-270 (1977) 10 figs, 4 tables, 16 refs

Key Words: Machine tools, Frequency response method, Chatter, Measurement techniques

The measurement of the frequency responses of machine tool structures is necessary because of the association between frequency response and chatter with consequent limitation of productivity. Various alternative techniques have been suggested. The paper describes comparative measurements of the frequency response of two systems using several techniques. The techniques examined were sinusoidal excitation with digital analysis, frequency incremented manually; slowly swept sinusoidal excitation with analog analysis; fast swept sinusoidal excitation with digital analysis; impulse excitation with digital analysis; and band-limited random excitation with digital analysis.

78-1501

Automated Optimum Design of Machine Tool Structures for Static Rigidity, Natural Frequencies and Regenerative Chatter Stability

C.P. Reddy and S.S. Rao

Dept. of Mech. Engrg., Regional Engineering College, Warangal-4, India, J. Engr. Indus., Trans. ASME, 100 (2), pp 137-146 (May 1978) 12 figs, 6 tables, 21 refs

Key Words: Machine tools, Optimum design, Minimum weight design, Finite element technique

A computational capability for the automated optimum design of complex machine tool structures to satisfy static rigidity, natural frequency and regenerative chatter stability requirements is developed in the present work. More specifically, the mathematical programming techniques are applied to find the minimum-weight design of Warren-type lathe bed and horizontal knee-type milling machine structures using finite-element idealization. The Warren-type lathe bed is optimized to satisfy torsional rigidity and natural frequency requirements, whereas, the milling machine structure is optimized with constraints on static rigidity of the cutter center, natural frequency and regenerative chatter stability.

78-1502

Matrix Representation and Prediction of Three-Dimensional Cutting Forces, Including Chatter

C.D. McKindra

Ph.D. Thesis, Univ. of Maryland, 222 pp (1977) UM 7808184

Key Words: Metal working, Cutting, Chatter

This research is concerned with three-dimensional metal cutting. An improved mathematical model was developed to predict three-dimensional steady-state cutting forces and represented in matrix form. Cutting is assumed to be in a plane so that the two-dimensional cutting theory can be applied. The location of the plane is such that the forces in it give rise to components along all three orthogonal directions.

78-1503

Bivariate Time Series Analysis of the Effective Force Variation and Friction Coefficient Distribution in Wood Grinding

W.R. DeVries, D.A. Dornfeld, and S.M. Wu

Dept. of Mech. Engrg., Univ. of Michigan, Ann Arbor, MI, J. Engr. Indus., Trans. ASME, 100 (2), pp 181-185 (May 1978) 4 figs, 2 tables, 10 refs

Key Words: Grinding machinery, Grinding (material removal), Coefficient of friction, Series (mathematics)

A new technique for analyzing the normal and tangential grinding force is presented. It can be used to extract the dynamic characteristics of the grinder structure, the work material, and measurement transducers from experimentally measured forces. Two sets of data from an experimental wood grinder are analyzed. Based on independent experiments, the frequencies in the measured normal and tangential forces can be related to factors other than the true grinding forces. The methodology developed is used to remove these dynamic effects and find the force and friction coefficient distributions.

78-1504

Development of an Experimental Setup for the Investigation of Grinding of Wood and a Proposal for a Pulsed Loading Technique

D. Dornfeld and S.M. Wu

Dept. of Mech. Engrg., The Univ. of California, Berkeley, CA, J. Engr. Indus., Trans. ASME, 100 (2), pp 147-152 (May 1978) 10 figs, 1 table, 11 refs

Key Words: Grinding machinery, Pulse excitation

The study of the fiberizing mechanism in the grinding of wood requires specialized laboratory equipment to allow process alteration and data collection. The design and development of a unique grinding setup and the control device and instrumentation needed for wood grinding research are outlined. A pulsed loading technique for increasing the effectiveness of the fiberizing mechanism is proposed and this technique is tested in a series of experiments conducted with the grinding operations.

PUMPS, TURBINES, FANS COMPRESSORS

(Also see No. 1382)

78-1505

Reducing Fan Noise in Construction Equipment

B.R. Baranski and J.J. Pisarski

Schwitzer, Wallace Murray Corp., SAE Paper No. 780455, 8 pp, 4 figs, 1 table, 7 refs

Key Words: Fans, Noise generation, Noise reduction, Construction equipment

Cooling system fan noise reduction can be best achieved by a combination of aerodynamic design and control of the fan environment. Design for minimum noise is a complex procedure that requires the optimization of fan geometry and fan environment, maximum efficiency at the operating point and the lowest possible blade tip speed. Good noise measurements are essential to research and development activities in fan noise reduction. Computer aided design techniques are required to optimize the fan.

78-1506

Method of Fan Sound Mode Structure Determination

G.F. Pickett, T.G. Sofrin, and R.W. Wells

Commercial Products Div., Pratt and Whitney Aircraft Group, East Hartford, CT, Rept. No. NASA-CR-135293, PWA-5554-3, 160 pp (Aug 1977)

N78-17064

Key Words: Fans, Noise generation, Modal analysis

A method for the determination of fan sound mode structure in the inlet of turbofan engines using in-duct acoustic pressure measurements is presented. The method is based on the simultaneous solution of a set of equations whose unknowns are modal amplitude and phase. A computer program for the solution of the equation set was developed.

78-1507

Noise Characteristics in Partial Discharge of Centrifugal Fans (1st Report. Low-Frequency Noise Due to the Rotating Stall)

S. Suzuki, Y. Ugai, and H. Harada

Noise Control Engrg. Center, Central Res. Inst., Ebara Corp., Fujisawa-shi, Japan, Bull. JSME, 21 (154), pp 689-696 (Apr 1978) 22 figs, 1 table, 3 refs

Key Words: Fans, Noise generation

Low-pressure centrifugal fans often produce low-frequency discrete noise, when operating in partial discharge. In this study, an attempt was made to find the cause of low-frequency discrete noise, using various parameters.

78-1508

Acoustic Problems in the Planning of Gas Turbine Power Plants (Akustische Probleme bei der Planung von Gasturbinenkraftwerken)

J. Meyer

Kraftwerk Union A.G., Mulheim, West Germany, DFVLR Contrib. to Steady and Unsteady Aerodyn., pp 215-226 (Aug 10, 1977)

(In German)

N78-17019

Key Words: Gas turbines, Electric power plants, Noise generation, Noise reduction

The planning of gas turbine power plants is considered from the point of view of acoustic noise generation and its effects on humans inside and outside the plant. Some examples show to what extent primary measures at the source can reduce noise and how noise isolation or attenuation as secondary measure can be implemented outside the power plant. Cost optimization in the provision of these measures is also considered.

78-1509

The Solution of a Vibration Problem on a Turbine-Compressor Set Mounted on a Steel Foundation

J.N. Ramsden and J.R Stoker

Mech. Engrg. Lab., GEC Power Engrg. Ltd., Whetstone, Leicester, UK, Inst. Mech. Engr. Proc., 191 (15), pp 135-145 (1977) 10 figs, 5 refs

Key Words: Steam turbines, Turbines, Compressors, Flexible foundations, Mathematical mpdels, Vibration control

The paper describes a vibration investigation undertaken as part of the commissioning of a 12 M.W. steam-turbine driven blower. The set which was mounted on a flexible steel foundation, suffered severe vibration of the exhaust-end pedestal of the turbine. Early attempts to cure the vibration had failed. To avoid further delays it was decided to make a theoretical model of the machine and its foundation and to develop this until it agreed with measurements taken at site. Having proved the theoretical model it was then to be used to try out suggested modifications to the foundation to see if a solution could be found. The results of these efforts are reported.

78-1510

Vibration Effects of the Space Shuttle Main Engine High Pressure Oxidizer Turbopump Bellows

J.A. Harp

Marshall Space Flight Center, NASA, Huntsville, AL, Rept. No. NASA-TM-78157, 56 pp (Feb 1978) N78-19190

Key Words: Bellows, Turbine components, Spacecraft components, Vibration tests

A welded metal bellows was subjected to a series of vibration tests in a 400 psi oxygen environment to evaluate the effects of the bellows convolutes rubbing on the damper ring in the high pressure oxidizer turbopump of the space shuttle main engine. The bellows was subjected to approximately 2 million cycles at 0.007 in. double amplitude displacement during this series of tests, at a frequency of 400 Hz. Instrumentation of the test specimen revealed no significant heat buildup caused by the rubbing of the bellows convolutes on the damper ring. A final destruct test was made to determine if a fire would result if the bellows ruptured in the 400 psi oxygen environment, thus exposing a fresh metal surface. The vibration input was changed to 0.8 in. double amplitude displacement at 20 Hz to intentionally rupture the bellows. Failure occured after 2.5 sec; no fire or heat buildup was encountered.

RAIL

(See No. 1441)

REACTORS

(See Nos. 1399, 1400, 1459)

ROAD

78-1511

Noise Reduction in Cabs of Trucks and Large Tractors

G.H. Koopman

Univ. of Houston, Houston, TX, Combined Environments Technology Interrelations: Proc. of the 24th Annual Technical Mtg. of the Inst. of Environmental Sciences, Fort Worth, TX, pp 394-397 (Apr 18-20, 1978) 6 figs, 4 refs

Key Words: Trucks, Tractors, Noise generation, Noise reduction

This paper reviews the physical mechansim behind the production of low frequency tones in cabs of trucks and tractors and describes a method for diagnosing and correcting the problem when it occurs.

ROTORS

78-1512

Modal Analysis of Turborotors Using Planar Modes – Theory

E.J. Gunter, K.C. Choy, and P.E. Allaire

Dept. of Mech. Engrg., Univ. of Virginia, Charlottesville, VA 22901, J. Franklin Inst., 305 (4), pp 221-243 (Apr 1978) 9 figs, 3 tables, 24 refs

Key Words: Rotor-bearing systems, Turbine components, Modal analysis, Critical speeds

The generalized dynamic equations of motion have been obtained by the direct stiffness method for multimass flexible rotor bearing systems including the effects of gyroscopic moments, disc skew, and rotor acceleration. A set of undamped critical speed mode shapes calculated from the average horizontal and vertical bearing stiffness is used to transform the equations of motion into a set of coupled modal equations of motion. The modal equations are coupled by the generalized bearing coefficients and the gyroscopic moments. An analysis using only undamped critical speeds or decoupled modal analysis assuming proportional damping may lead to erroneous results. This paper presents a rapid method of calculating rotor resonance speeds with their corresponding amplification factors, stability and unbalance response of turborotors. Examples of the application of this modal approach are presented and results are compared to those of other methods such as matrix transfer analysis.

78-1513

Measurement of Unsteady Pressures in Rotating

Systems (Zur Messung instationaerer Druecke in rotierenden Systemen)

K. Kienappel

Inst. fuer Aeroelastik, Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Goettingen, West Germany, Contrib. to Steady and Unsteady Aerodyn., pp 125-136 (Aug 10, 1977) (In German)

N78-17013

Key Words: Rotating structures, Periodic response

The principles of the experimental determination of unsteady periodic pressure distributions in rotating systems are dealt with. An indirect method is discussed, and the effects of the centrifugal force and the transmission behavior of the pressure measurement circuit are outlined. The required correction procedures are described and experimentally implemented in a test bench. Results show that the indirect method is suited to the measurement of unsteady nonharmonic pressure distributions in rotating systems.

SHIP

(Also see No. 1406)

78-1514

Impedance-Based Motion Prediction, Scaling, and Environmental Simulation for Shock Applications

F.B. Safford

Agbabian Associates, El Segundo, CA, Rept. No. AA-R-7710-4500, NRL-MR-3676, AD-E000 109, 205 pp (Dec 1977)

AD-A050 116/3GA

Key Words: Naval ships, Submarines, Shock resistant design, Mechanical impedance, Scaling

The ability to predict and simulate acceleration-time histories at the actual mounting locations of weapon system components will provide vital knowledge for protecting and hardening these components to meet present and changing mission requirements of naval ships and submarines. Mechanical impedance/mobility techniques, long a tool of the experimenter, have now evolved to practical methods under engineering conditions. This report summarizes current activities in the measurement of structural dynamic functions, usable methods for predicting response to environmental threats, and a new method for environment-simulation testing.

SPACECRAFT

(See No. 1510)

TRANSMISSIONS

78-1515

The Influence of Lubrication on Tooth-Roller Impacts in Chain Drives

J.N. Fawcett and S.W. Nicol

Dept. of Mech. Engrg., Univ. of Newcastle-upon-Tyne, UK, Instn. Mech. Engr. Proc., 191 (21), pp 271-275 (1977) 6 figs, 4 refs

Key Words: Chain drives, Noise reduction, Lubrication

In a roller chain drive an impulsive load occurs each time a roller is picked up by the driving sprocket from the chain span. These impulsive loads cause high frequency sprocket angular accelerations of large amplitude, and are the source of high frequency chain noise. Measurements of sprocket acceleration immediately after impact have been made to demonstrate the effects of different methods of lubrication on the magnitude of the impulse. Oil drip, oil jet and oil bath lubrication have been investigated for normal machine oil and very high viscosity oil. The results show considerable variations in acceleration amplitude.

78-1516

Reduction of Noise and Vibration in Roller Chain Drives

S.W. Nicol and J.N. Fawcett

Dept. of Mech. Engrg., Univ. of Newcastle-upon-Tyne, UK, Instn. Mech. Engr. Proc., 191 (39), pp 363-370 (1977) 9 figs, 2 refs

Key Words: Chain drives, Noise reduction, Vibration control

A method of eliminating high frequency noise and vibration in a constant torque chain drive is described. Experimental results compare noise and vibration levels in standard and modified configurations.

AUTHOR INDEX

CALENDAR

NOVEMBER 1978

26-30 Acoustical Society of America [ASA] Salt Lake City, UT *(ASA Hq.)*

26-Dec 1 Acoustical Society of America, Fall Meeting, [ASA] Honolulu, Hawaii *(ASA Hq.)*

27-30 Aerospace Meeting, [SAE] Town & Country, San Diego, CA *(SAE Meetings Dept., 400 Commonwealth Dr., Warrendale, PA 15096 - Tel. (412) 776-4841)*

DECEMBER 1978

4-6 15th Annual Meeting of the Society of Engineering Science, Inc., [SES] Gainesville, FL *(Prof. R.L. Sierakowski, Div. of Continuing Education, Univ. of Florida, 2012 W. University Ave., Gainesville, FL 32603)*

10-15 Winter Annual Meeting, [ASME] San Francisco, CA *(ASME Hq.)*

11-14 Truck Meeting, [SAE] Hyatt Regency, Dearborn, MI *(SAE Meetings Dept., 400 Commonwealth Dr., Warrendale, PA 15096 - Tel. (412) 776-4841)*

FEBRUARY 1979

26-Mar 2 Congress & Exposition, [SAE] Cobo Hall, Detroit, MI *(SAE Meetings Dept., 400 Commonwealth Dr., Warrendale, PA 15096 - Tel. (412) 776-4841)*

APRIL 1979

30-May 2 NOISE-CON 79 [INCE] Purdue University, IN *(NOISE-CON 79, 116 Stewart Center, Purdue University, West Lafayette, IN 47907 - Tel. (317) 749-2533)*

30-May 2 Environmental Sciences Meeting, [IES] Seattle, WA *(Dr. Amiram Roffman, Energy Impact Assoc., Inc., P.O. Box 1899, Pittsburg, PA 15230 - Tel. (412) 256-5640)*

MAY 1979

20-25 Spring Meeting and Exposition, [SESA] San Francisco, CA *(SESA, 21 Bridge Square, P.O. Box 277, Saugatuck Sta., Westport, CT 06880 - Tel. (203) 227-0829)*

JUNE 1979

11-15 Acoustical Society of America, Spring Meeting, [ASA] Cambridge, MA *(ASA Hq.)*

SEPTEMBER 1979

10-12 ASME Vibrations Conference, [ASME] St. Louis, MO., *(ASME Hq.)*

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